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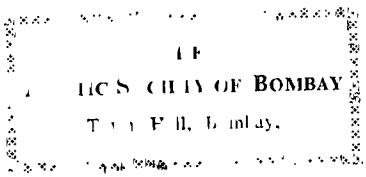

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DOCUMENTS

REGARDING THE

NAVIGATION OF THE GANGES

FROM

ALLAHABAD TO REVULGUNGE

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TO THE MOUTH OF

THE GOGRA.

CALCUTTA:

J. C. SHERRIFF, MILITARY ORPHAN PRESS.

1849.

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LIST OF REPORTS AND PAPERS ON THE NAVIGATION OF THE GANGES FROM ALLAHABAD TO REVELGUNGE AT THE MOUTH OF THE GOGRA.

No. 1. From F. H. SIMMS, Esquire, Consulting Engineer to the Government of India, and Director of the Railway Department, to A. SHAKESPEAR, Esquire, Assistant Secretary to Government N. W. P., dated 26th May, 1846. Report upon the Ganges River with suggestions for improving its navigation.

No. 2. Letter from Captain A. H. E. BOILEAU, Engineer, attached to the Railway Department, to Captain T. E. RODGERS, Indian Navy, Officiating Superintendent of Marine, dated 29th June, 1846, showing the causes of the impediments met with by the up-country Steamers in March and April, and how to be obviated.

No. 3. From Captain W. M. SMYTH, Officiating Superintending Engineer, to the Secretary to Government N. W. P., without date. Remarks on the plan proposed by Mr. SIMMS, for improving the navigation of the Ganges.

No. 4. Memorandum relative to the improvement of the navigation of the Ganges between Allahabad and Revelgunge, submitted in a letter from E. A. READE, Esquire, Commissioner of the Benares Division, to J. THORNTON, Esquire, Secretary to Government N. W. P., No. 57, dated 5th October, 1847.

No. 5. Letter from A. SHAKESPEAR, Esquire, Assistant Secretary to Government N. W. P., to E. A. READE, Esquire, Commissioner of Benares, No. 826, dated 26th October, 1847, in reply to Mr. READE's letter forwarding his memorandum on the improvement of the navigation of the Ganges.

No. 6. Letter from Captain W. M. SMYTH, Engineer, Officiating Superintending Engineer, Lower Provinces, to Captain A. DALLAS, Officiating Secretary Military Board, No. 1184, dated 31st July, 1848, reporting on the difficulties experienced in navigating the Ganges, with maps and plans.

No. 7. Letter from E. A. READE, Esquire, Commissioner of Benares, to C. ALLEN, Esquire, Officiating Secretary to Government N. W. P., Agra, No. 27, dated 10th October 1848, reporting on the navigation of the River Ganges and the removal of the obstructions therein.

Enc. to the above No. 1. No. 8. From MR. LLOYD, Superintendent, Ganges Works, to E. A. READE, Esquire, Commissioner of Benares, dated June, 1848. Remarks on the reports furnished and the improvements effected on that portion of the Ganges between Allahabad and Revelgunge.

Enc. No. 2. No. 9. Instructions issued by the Commissioner of Benares to MR. ALONE, River Inspector, for ascertaining with accuracy the traffic of Boats on the River Ganges, within the range of the Benares Division.

Enc. No. 3. No. 10. Abstract of the Register of Boats proceeding upwards, from 1st July, 1847 to 30th June, 1848, within the range of the Benares Division.

Enc. No. 4. No. 11. Abstract of the Register of Boats proceeding downwards from the 1st July 1847 to 30th June 1848, within the range of the Benares Division.

Enc. No. 5. No. 12. Quarterly Abstracts of the Register of Boats proceeding upwards, within the range of the Benares Division, from 1st July, 1847 to 30th June, 1848.

Enc. No. 6. No. 13. Quarterly Abstract of ditto, downwards from ditto ditto.

Enc. No. 7. No. 14. Memorandum of expenses incurred in ascertaining the traffic on the River Ganges, passing within the range of the Benares Division and for removing the obstructions in the river.

No. 15. Extract from a letter from Captain A. H. E. BOILEAU, to the Hon'ble the Lieutenant Governor N. W. P., dated 16th September, 1848. Remarks on the operations for improving the navigation of the Ganges River.

REPORT

UPON

THE RIVER GANGES,

WITH

Suggestions for improving its Navigation.

FROM F. W. SIMMS, ESQUIRE,

Consulting Engineer to the Government of India,
and Director of the Railway Department,

TO A. SHAKESPEAR, ESQUIRE,

Assistant Secretary to the Government N. W. P.,

DATED 26TH MAY, 1846.

SIR,

I have the honor to submit my Report upon the River Ganges, as desired by the Hon'ble James Thomason, Esquire, Lieutenant Governor of the North-Western Provinces, in a letter from yourself, No. 201, dated Agra, 7th March 1846.

2nd. The opportunity I had for examining the river, was far more limited than I should have desired, being confined to a journey by Steam from Allahabad to Calcutta, nevertheless I could not have had a more favorable time for my observations and remarks, as the water in the river was probably shallower than has been known for several dry seasons past.

3rd. The difficulties of the navigation of the upper part of the Ganges, in the dry season, or from November to May inclusive, arise from a deficiency of depth of water, and the continued changing of the respective channels from day to day, and in many cases from hour to hour, as a small obstruction in the river causes the sandy bed to shift most rapidly, and to form bars and new shoals in places, where an hour or two before, no such obstruction existed.

4th. This continual changing of channels renders the navigation of the river extremely puzzling, and although Native Pilots are employed along the river, at intervals of twenty-five miles, with assistants, whose business it is to make themselves constantly acquainted with the existing channels from day to day, yet, so far as I could judge from what I observed in my passage, this duty appears to be most inefficiently performed, whereas it is a matter of the first importance.

5th. As a sample of the delay arising from the above causes, I will state some particulars of the time consumed to perform my passage from Allahabad to Calcutta, on board the *Soane* (Flat) in tow of the *Lord William Bentinck* (Steam Vessel.) I left Jumna Ghat, Allahabad, at 6 A. M. of March 25th last, and anchored off Kidderpore Dock at Calcutta at 9 P. M. of April 16th, the interval being 22 days and 15 hours.

	From	To	Number of hours actually travelling or attempting to travel.	Approximate distance in miles, by crooked channels.	Rate in miles per hour.
1	Allahabad, ...	Sirsa,...	63	25	0.397
2	Sirsa, ...	Mirzapore, ...	9	61	6.777
3	Mirzapore, ...	Sultanpore, ...	43	34	0.791
4	Sultanpore, ...	Benares, ...	4	18	4.500
5	Benares, ...	Ghazeepore, ...	12	70	5.833
6	Ghazeepore, ...	Buxar, ...	9	31	3.444
7	Buxar, ...	One mile below the old mouth of the river Surjoo, ...	43½	19	0.436
8	One mile, &c. as above,	Dinapore, ...	11	74	6.727
9	Dinapore, ...	Monghyr, ...	22½	122	5.422
10	Monghyr, ...	Rajmahal, ...	23	144	6.261
11	Rajmahal, ...	Rampoor Beauleau,	14	100	7.143
12	Rampore Beauleau,	Commercolly, ...	10	68	6.800
13	Commercolly, ...	Culna, ...	19	134	7.052
14	Culna, ...	Calcutta, ...	47	263	5.600
		Total, ...	330	1163	3.524

6th. The preceding Table shows the time we were actually occupied in proceeding from point to point, including the time we were aground or delayed by the state of the river, and of course, is exclusive of nights, during which the vessels are professedly brought to an anchor. The total time occupied in performing the journey as above was 330 hours, and the distance about 1163 miles going an average rate of 3.524 miles per hour, but the actual time, including nights, was 543 hours, giving an average of 2.142 miles per hour, or in round numbers 2 miles, 1½ furlongs per hour.

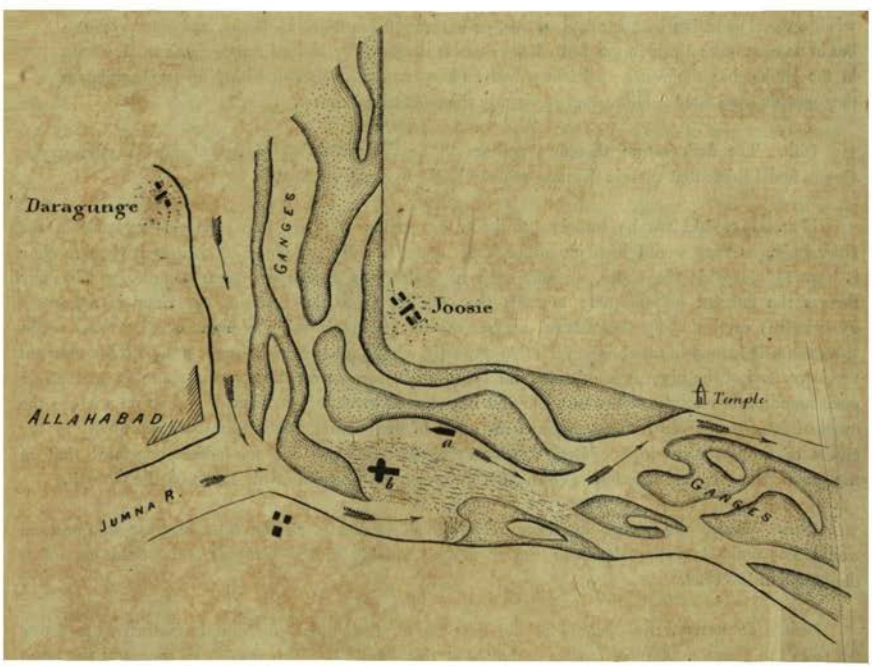
7th. The chief difficulty in the navigation lies:—1st, between Allahabad and Sirsa.—2nd, between Mirzapore and Sultanpore,—and 3rdly, between Buxar and one mile below the old mouth of the river Surjoo.

8th. In the first portion, the whole distance is full of difficulty, in the 2nd, the chief difficulty lies between Kutchwa and Sultanpore, and the 3rd, begins about 8 miles below Buxar and terminates, as above stated, one mile below the old mouth of the river Surjoo.

9th. The Steam Vessel, (the *Lord William Bentinck,*) was as light as she could be, when ready for a voyage, having no cargo, and drew 3 feet 3 inches of water,—her power equal 90 horse.

10th. The Flat, (the *Soane,*) when she left Allahabad also had no cargo, and drew 22 inches, at Mirzapore she took in 180 bales of cotton, each weighing 300lbs., which caused her to draw 28 inches of water, the remainder of the cargo consisted of 278 bales of 300lbs. each and was taken in at Sultanpore, whereupon she drew forward 3 feet 4 inches and aft 3 feet 9 inches.

11th. The river itself has a very tortuous course, but the navigable channels, left by the shifting sands, are still more tortuous. Some of the shoals were of a singular form and closed the channel altogether; this was chiefly the case near the confluence of rivers that fall into the Ganges, and where the main river expands to a great breadth. The first shoal that arrested our progress, very soon after leaving Allahabad, was of the above kind, and entirely closed the channel to any vessel drawing above 9 or 10 inches of water, and the only way of getting both Steamer and Flat over from one channel to the other, was by carrying out anchors and heaving upon them, a very laborious and tedious operation, and was the only method resorted to in all similar situations throughout the voyage. The following sketched plan represents the above-named shoal as it existed on the 25th and 26th of March last.



The arrows denote the channel.
'*a*' The position of the Flat, (the *Soane,*) on the morning of March 26th, after getting over the shoal.
'*b*' The position of the Steamer (the *Lord William Bentinck*) at the same time.
Scale of Plan one inch to one mile.
N. B.—The Plan is but an approximation to accuracy.

12th. However bad the state of the river may be, I am far from believing that the universal detention of these vessels during the dry season is wholly owing to that cause; some part thereof is due to the imperfect pilotage as before stated, and I am inclined to think that if the remuneration of the Commanders and other Officers was, in some way, made partly dependent on the time occupied in the trips, some abbreviation of the average time would take place.

13th. Such was the state of the river at the period above-named, and it will now be necessary to enter upon the consideration of its improvement, in attempting which, we should follow and assist rather than force Nature in her operations.

14th. The deepening and keeping open a channel by means of a Dredging Machine, would, I consider, in this case be a fertile waste of money, and therefore not to be entertained for a moment.

15th. The object to be aimed at, is to keep the waters of the river from spreading over so large a surface as they now do. In the rainy season there is abundance of water over its whole breadth, (or nearly so) but in the dry season so little water passes down, in comparison with the width of the river's bed, that its force is entirely destroyed, and the only power it has is to keep the sand as it were alive, and facilitate its shifting from one spot to another, according as circumstances may cause a fresh set in the current; these circumstances are various, they may be the wind, a vessel or native boat aground, a tree, or masonry fallen from the banks, and many others: but in no case, except where the bed of the river is narrowed by natural causes, (as kunkur strata in the banks) has the water sufficient power to keep any channel from silting up or changing, as they now do from hour to hour, from apparently the most trivial causes.

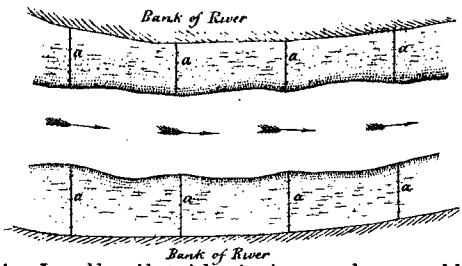
16th. The desideratum therefore appears to be the narrowing of the channel in the dry season, and I think that such is the only remedy likely to prove successful.

17th. It would not be sufficient to throw out groins or spurs from one side or bank of the river only, as that would have no other effect than is daily produced by Nature, when a chur is formed alongside the shore, around such a nucleus as a tree or fallen temple, which chur throws the current off obliquely towards the opposite shore, and (where the river is not *great* in breadth) carries away the natural surface of the ground, leaving a bight or bay; here again the stream is turned in an oblique direction onwards, which, in its course, leaves a deposit, or chur, at the lower end of the bight it is quitting, and being again thrown on the opposite shore it excavates a corresponding bay on the side where the first impediment or chur was formed, and so on; hence the crooked courses of rivers: this action and the effect of such action, I have observed repeatedly in the rivers of the lower provinces of Bengal, where their breadths are but one-half or one-third that of the main Ganges, and the banks consisting of the general alluvion of the Delta of the Ganges.

18th. Where the rivers are very wide, the above action, at the time of year in question, would be confined to the shoals of the river (particularly in the Ganges) and would not affect the banks in the least.

19th. To narrow the channel in the dry season, I should so far imitate Nature as to throw out from the shore a groin or artificial chur, but this should be done from both shores at the same time, placing the groins opposite each other and in the same straight lines, the pairs of groins being placed at no great distances apart; the effect of this arrangement would clearly be to prevent the wanderings of the water and to confine it to the channel left between the extremities of the groins, and the internal spaces from groin to groin would very soon silt up, and the scour would be wholly confined to the channel, where its services would be essential.

20th. To prevent the possibility of being misunderstood, I have annexed the following Sketch in which *a a*, &c., represents the proposed groins.

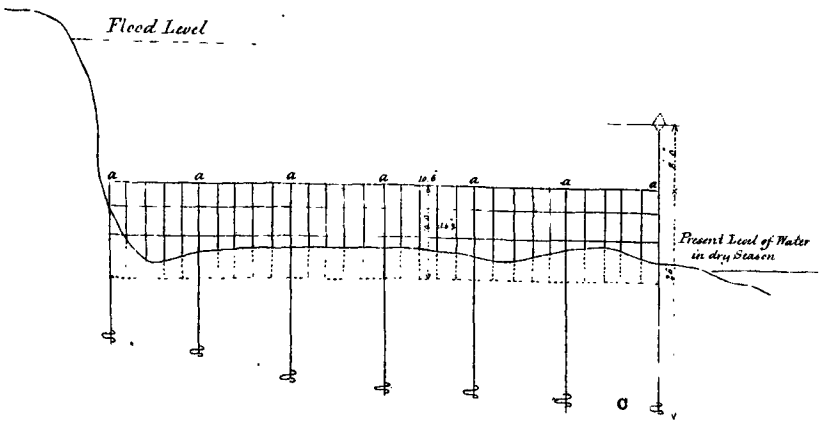


21st. In narrowing the river I would avoid straightening its general course, although I would get rid of its many numerous small bends. In doing this, I would reduce the entire length of the channel, but very little if at all, for although it might be desirable in itself to do so, yet I am of opinion, that it would defeat, in a great measure, the object we have in view.

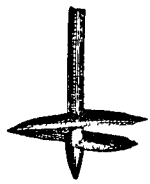
22nd. By straightening the course of the river we shall increase its fall, and thereby obtain a greater scour, but in so doing we should let the water pass off more rapidly, and we should be likely to have less water in the upper part of the river than we now have; it would therefore appear undesirable materially to straighten the channel, but by causing all the water, that now flows through the very numerous shallow channels, and over the general surface of the shoals, to take one course only, we should get a greater depth of water in that course.

23rd. The construction of the groins was the next consideration. Three different plans of effecting this object were devised and considered by me, but the one that appears to be the best suited in every respect is an application of Mitchell's screw mooring, which, in the form of a screw pile, has answered so well in England, to form the Maplin and Wyre lighthouses, erected on the submerged sands, at the mouth of the Thames and Wyre.

24th. The annexed Sketch shows a longitudinal Section of one side of the river, with a groin extending from the shore, to narrow the water-way in the dry season, as above described.

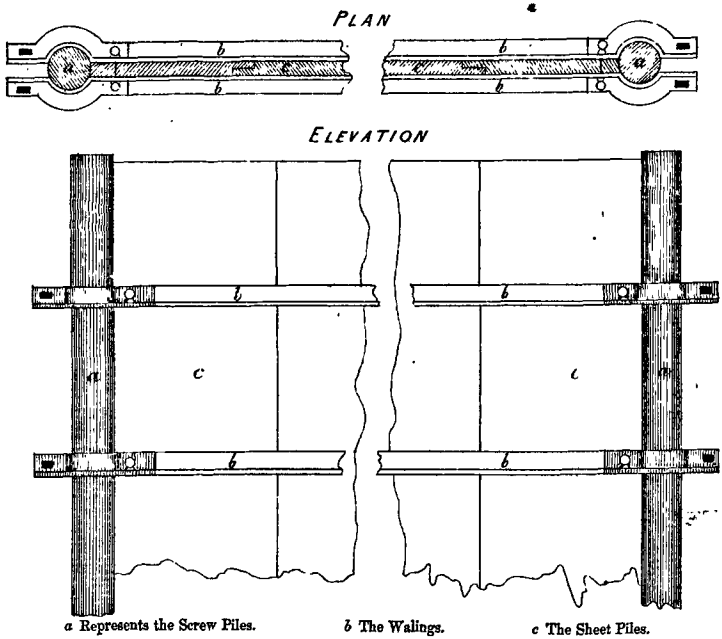


25th. The piles *a a*, &c., are round rods of malleable iron, each having a worm fixed to its lower extremity as shown in the following figure.



26th. The main or extreme pile nearest the channel, should not be less than four inches diameter, and should be of a sufficient length to allow 20 feet being imbedded in the bed of the river, the two next innermost piles might be 3 inches diameter and 23 feet long, and the subsequent piles might be 2 inches diameter and 20 feet long.

27th. The screw piles should be placed at equal intervals, say 10 feet 6 inches apart in the clear, and should be connected by four iron walings, two on each side, placed opposite each other, leaving two vertical openings, of an inch and a quarter each, the whole distance from pile to pile, the one opening being vertically over the other precisely as the walings are fixed for the reception of the piles in the construction of a coffer-dam, and answering in this case a precisely similar purpose; for through the spaces between the walings, I propose cast iron sheet piles to be passed, to close the interval or bay between the main screw piles before described, such sheet piles to be 10 feet long and 18 inches wide with rabbeted edges to overlap each other; this will be clearly understood from the following Sketch of one of the bays in plan and elevation.



a Represents the Screw Piles. *b* The Walings. *c* The Sheet Piles.

28th. The bays or intervals between the screw piles might be filled up with faggots or other materials less expensive, in the first instance, than the cast iron sheet piling above described, but such would be imperfect and perishable, requiring constant watching and repairing, which would probably soon involve as great an outlay as that for the iron piling, and after all it would be attended with danger to the whole works; for if any one portion of a bay be washed away, an opening would be made for the passage of the sand and water, and the destruction or removal of the remainder would soon be the consequence, and the whole would have to be renewed. Such economy would perhaps prove unwise, and I propose the iron sheet piling as neither perishable within a long period, nor liable to removal by the action of the water; and furthermore, if at any time the water should have a tendency to force its way under the said piles and carry away the sand therefrom (which would inevitably be the effect) the sheeting piles would continue to sink, and following downwards continue to close up the passage below, or in other words they being loose between the walings, (or bolted thereto, and their collars fitting loosely on the screw piles, as may be found best) would press upon its bed and prevent such under-passage being formed at all.

29th. Having now explained my plan generally, it will be unnecessary to go into more minute details of the construction and the means to be employed in fixing the piles, &c., all of which are extremely simple, unless it should please the Hon'ble the Lieutenant Governor to approve of the project and give me instructions to have any portion of it carried into effect, in that case I will contrive, and provide for every detail and contingency; it will therefore be only necessary for me to state what my opinion is as to the cost of the works complete, which approximately I consider will average about £60,000 per mile of the river; and with this data, the total cost of groins for any given length of river can readily be determined. The above sum is much greater than I expected it to have been, but I do not think it can be done for a great deal less just now, the price of iron being so very high; hereafter, when iron works become common in this country, a very material difference will be found in these cases, and probably if a large contract for this work was offered to competition at the present time in this country and in England, a lesser sum than I have named might be found to suffice.

30th. It will be understood from the foregoing description, that the groins will stand but a few feet above the present surface of the sand in the dry seasons, which will be ample for confining the water within a narrow channel; it will therefore be clear that as the waters rise with the advance of the rainy seasons, the groins will early be submerged, and that to a great depth towards the end of the Rains; under these circumstances it might appear that when covered and out of sight, they would prove dangerous to vessels passing over them; such would in reality be the case until they were covered to a greater depth than is drawn by any of the vessels navigating the river, which probably might be 5 or 6 feet. Therefore until the water shall have attained this depth over the groins, it will be absolutely necessary to buoy off the real channel to warn vessels from passing certain limits either to the right or left; but when a sufficient depth of water is obtained, say 6 or 8 feet, it will be quite unimportant what part of the river may be traversed, and all that appears to be requisite to guard against accidents will be to attach small buoys to the external screw piles, with sufficient chain to allow them to rise with the water to a height, not greater than to indicate the minimum of depth necessary for safely traversing the river indiscriminately, and so long as the buoys continue visible, the vessels must be confined to the channel between them.

31st. I have proposed that the buoys be attached to the pile-heads by means of chains, which will be the simplest mode of doing it, one objection that might be raised thereto, is the fact that the buoy would not be vertical over the pile, except when the water is just about to submerge it, this objection, however, is trifling, because the vessels would, or ought not to pass so close to the buoys as to be in danger. I had thought of another method whereby the buoys would always be vertically over the piles, but as this would require a peculiar construction, liable to derangement in its action, in

such a situation, whereby the utility of the buoy would be altogether lost, I consider that the method of attachment by the chain would be the simplest and best for adoption.

32nd. I do not consider my scheme of the iron groins as applicable only to the case under discussion, but it will be found to answer in corresponding cases elsewhere; not merely to increase the depth of water in a channel, but by appropriate modifications to secure the banks of any Indian rivers from the destructive action of currents, and thus occasionally protect very valuable property.

33rd. When at Agra in February last, I was struck with the apparent danger of that beautiful structure, the Taj Mehal, from the encroachment of the river on the west side, threatening at no distant period to undermine the foundation of the north-west angle of the outward buildings. Immediately west of the Taj and from thence towards the citadel, the land, including a public highway, has been denuded to a very great extent, forming a bight or bay at the angle of the river opposite the reach, that extends northward past the City, which denudation has arisen from causes similar to those described in a preceding part of this Report; here then we have a suitable case for the application of the iron groins, and I feel confident that such a proceeding would, in addition to securing so fine a building from danger, maintain an ample space of ground for a roadway along the water side, in lieu and in extension of the one now washed away.

34th. The preceding paragraph respecting the preservation of the Taj may perhaps be deemed irrelevant to the subject of this Report, but I am tempted to make the suggestion, as I feel it to be a duty we owe to posterity, to hand down, in as perfect a state as possible, all buildings, antiquities, and objects of interest, that have afforded so much pleasure to ourselves.

35th. But returning from this digression, I will add a remark on the propriety of incurring any large outlay in removing the difficulties of the navigation of the upper part of the river, with the probability that exists of an early commencement of the Railroad in the vicinity of Allahabad. In the Report upon Railways, lately delivered to the Government of India, it is recommended that the line from Calcutta to Delhie should pass through Saseram, Chunar, Mirzapore, and Allahabad, with a branch line diverging from about 9 miles south-east of Chunar to Raj Ghat, opposite to Benares, a distance of about 17 miles.

36th. Under such circumstances, the advisability of incurring so large an outlay, as would be necessary for the improvement of the river between Benares and Allahabad, appears to be doubtful, because a convenient landing place, erected at Raj Ghat and adjoining the Railway Terminus, would obviate the necessity for the Steam Boats proceeding higher than Benares during the dry season; if, however, it be desirable that they should proceed further up, a similar landing place might be constructed at Chunar, as the difficulties of the navigation between Benares and Chunar are at present confined to the first 3 or 4 miles downwards from the latter place, and scarcely extend below Sultanpore.

37th. It would therefore appear desirable that the works of the Railway, between Benares and Allahabad, or Chunar and Allahabad, should be amongst the earliest that are commenced, and I feel myself warranted in advising both the Government and the Railway Company to that effect, as being best calculated to promote their mutual, and the public interests.

38th. If the Hon'ble the Lieutenant Governor should concur in my views of the question, and also be disposed to adopt my plan for the improvement of the navigation, its employment might be confined, in the first instance, to the few miles below Buxar, near to Bulleea, the cost of which would probably be about the sum stated above, but in naming this sum as the probable outlay, I must again,

in justice to myself, call attention to the fact that this statement is but approximate, and that without making a minute survey of the portion of the river to be operated upon, to enable me to go into the necessary details of my plan, it is quite impossible for me to give an estimate of the actual necessary expenditure.

I have, &c.,

(Signed) F. W. SIMMS, C. E.,

Consulting Engineer to the Govt. of India, and Director of the Railway Department.

CALCUTTA, *The 26th May*, 1846.

NOTE.—Since the preceding Report was written, I have been shown the original of a Chart of the River Ganges, from Allahabad to Calcutta, which is now preparing for publication; it is in fact, Captain Prinsep's revision of Major Colebrook's Survey, corrected to the present time. It is called an "Eye-sketch of the Ganges, and Rivers used by the Inland Steam Company," and although it professes to be but an "eye-sketch," yet upon an examination I found it to agree essentially with my own observations, in descending the river, and I have no doubt, but if I had possessed such a document in my recent journey, I should have found it very useful. The person by whom the "eye-sketch" was made, is Captain J. F. Stace, of the Ganges Steam Company.

(Signed) F. W. SIMMS.

FROM CAPTAIN A. H. E. BOILEAU, *Engineers, attached to the Railway Department,*

TO CAPTAIN T. E. RODGERS, *Indian Navy, Offg. Superintendent of Marine.*

DATED CALCUTTA, THE 29TH JUNE, 1846.

SIR,

Bringing to the notice of the Superintendent of Marine, the great delay experienced by the up-country Steam-boats in March and April.

With reference to a recent trip from Allahabad to Calcutta, performed in the Steamer *Lord William Bentinck* and Troop Boat *Soane*, by the Officers attached to the Railway Department, in the months of March and April last, and adverting to the great delay experienced, both by these vessels and by the numerous other up-country Steamers then navigating the River Ganges, I have the honor of forwarding for your consideration, (and for submission to Government if thought of sufficient importance,) the following remarks on the difficulties attending Steam Navigation to Allahabad at that time of the year, and the means of effectually overcoming them.

Shewing that the principal difficulty is not so much the want of water as the want of a fair channel.

2nd. The principal difficulty seems to arise not so much from the actual want of water in the river, as from the want of a proper channel or channels (as there should be two, one for the upward, and one for the downward bound vessels) in which there ought not anywhere to be less than 3 or 3½ feet of water; for on the subsidence of the floods caused by the periodical rains, although the bed of the Ganges shows a most unpromising mass of sand banks, and some parts of the stream are barely

more than 2 feet deep, until the supply of water is augmented by the melted snow from the Himaleh Mountains, yet it appeared that there was nowhere so little water in the entire section of the stream, as that it would not amply suffice for all purposes of Steam Navigation, if it were prevented from extending itself over the sandy flats, and were artificially compelled to confine itself to two proper channels.

Suggesting a method of forming a proper channel where the bed of the river is sandy.

3rd. Where the bed of the river is sandy the process of collecting the water into two channels would not, I think, be either difficult or expensive, and might probably be easiest and most economically performed in the following manner.

First.—Let a careful examination be made of the entire bed of the river from bank to bank in the neighbourhood of the shallows which obstruct the Navigation, and an accurate plan and sections be made of them, if the means be at hand, though this may often be dispensed with.

Secondly.—Let two of the most likely looking channels be marked out with strong *Saul Bullees* or *Soondry Pins* about 12 feet long, to be driven into the sand-like piles, and to be further steadied, if necessary, by three stays (two up the stream and one down the stream) anchored by gunny-bags filled with clay.

Thirdly.—Let gangs of native laborers be employed with iron rakes and hoes (or even with the common wooden fork called *Jeree*, or with their feet only, as has occasionally been done) in scratching up and loosening the sand, which will then be carried down by the current and be deposited elsewhere, while the required channels are thus gradually deepened: and care should be taken to commence this operation at the tail of the channel, that all the debris or moving silt may be carried clear away by the stream.

Recommending a trial of catch-water fenders made of hawsers armed with a fringe of bushes.

4th. Should this method of deepening the channel not give a sufficient supply, let catch-water fenders be formed at the heads of the various sand banks above the upper openings of the proposed channels, so as to turn down as much water through them as may ensure a supply of not less than 3 or 3½ feet as above-mentioned. These fenders may be made of thick hemp ropes or hawsers thickly set with bushes of the *Jhur-baree* or any other convenient shrubs, tied to them in the manner of a fringe, and may be staked down into the sand, or anchored by means of bags of clay, &c. Though not personally acquainted with the fact, I am told that this application of a bushed hawser has been found very efficacious in diverting a powerful current, when a far more expensive method had been tried in vain. The fenders ought probably to make a very acute angle with the course of the stream, or to be as little athwart the current as conveniently may be.

Stating what remedy can be applied where the obstruction is caused by beds of gravel or rock.

5th. Where the obstruction is caused by a bed of gravel rock or *kunkur*, a more expensive remedy must be applied similar to those by which the Jumna was partially cleared in the years 1826-27, &c., though I consider it desirable only to remove as small a portion of any such barrier as is consistent with perfect facility in getting boats across the obstacle, because where the cut through a bar of this kind is made too wide it does mischief to the reach of the river immediately above it, by allowing too great a portion of its waters to run off at once through the new cut. Beds of *kunkur* are removed by surrounding them with a water-tight bank of clay, which enables the interior space to be laid dry by baling or pumping, and enables the workmen to break up the calcareous concrete with pickaxes to the depth of 3 or 4 feet below the surface of the external stream.

6th. Masses of more solid kinds of rock, which will admit of the use of gunpowder, can be removed by blasting as was formerly done in the Jumna, suitable holes being made with the mining tools called jumpers, handborers, &c., by men standing up to their waists in the water, and the charges of powder are secured from injury by being enveloped in tin cases, with a thin chimney raising the quickmatch above the surface of the water; or even in some instances the charges are contained in paper tubes well greased and filled to the top (from the gunpowder upwards) with dry sand, after introducing a hollow reed to allow the priming to be conducted to the bottom of the tube.

Describing the operation of blasting rocks under water, as practised in the River Jumna.

7th. The principal obstructions in that part of the River Ganges, at present navigated by steam-boats, appear to be at Dumduma below Allahabad, at Kuctiwa below Mirzapore, and at Bulleea above Revelgunge or Chupra, and it *seems* likely that much good might be done by selecting three European invalid or pensioned Serjeants from Chunar or elsewhere, giving them a moderate allowance, say one Rupee daily, during three months, when their services would be most wanted, and placing a boat with two rowers and one diver at the disposal of each of them, with as many bildars, coolies or other native laborers as might be necessary to carry out at least as much of the proposed scheme of improvement, as is suggested in the 3rd and 4th paragraphs of this communication.

Recommending the employment of a small establishment during three months in the year under European Serjeants.

I have, &c.,

(Signed) A. H. E. BOILEAU, *Capt.*,
attached to the Railway Dept.

KYD STREET,
CALCUTTA,
The 29th June, 1846.

Remarks by Captain SMYTH, *Engineers, on the plan proposed by Mr.* SIMMS, *for improving the Navigation of the Ganges.*

1st. I have the honor to state for the information of the Hon'ble the Lieutenant Governor, North Western Provinces, that my experience of several years in works on the Nuddea Rivers, confirms the opinions expressed by Mr. Simms in paragraphs 13, 14, 15, and 16 of his "Report upon the River Ganges, with suggestions for the improvement of its Navigation."

2nd. That gentleman has seen at once the unfitness of dredging machines for removing shoals of shifting sand,—the disadvantage of attempting to shorten the course of Non-tidal Rivers by artificial channels,—and he has further stated his opinion that we must follow and assist Nature rather than force her in her operations, and that the only chance of success is to narrow the channel in the dry season.

3rd. He has proposed to effect this by means of iron groins ingeniously planned, but costly and perhaps otherwise open to objection; but before remarking upon this plan, I shall explain what is practised, with some success, on the Nuddea Rivers.

4th. Let the annexed Sketch 1, represent a part of the river obstructed by sunken shoals. The depth of water in feet before operations being, as shewn by the figures, 1, 1½, 1¾, &c. In order to render the passage navigable for boats drawing 3 feet of water, the Bandahls *a b c d e f* would be constructed, and in any of the Nuddea Rivers the desired effect would be produced as shewn in Sketch 2, provided there was a current of a mile an hour or upwards.

5th. The Bandahls are constructed as follows—A line of strong bamboo pins *a a*, from 10 to 15 feet long and placed about a foot apart, are driven from 5 to 6 feet into the sand; they are then bound with string to the double horizontal tie *b b*, formed of whole bamboos lashed together about 1 foot above the water, the struts *c c*, are placed at intervals of from 5 to 10 feet to support this bamboo fence.

6th. The pins are now allowed to remain one or two days, during which time the ties of such as may have been loosened by the current are opened, and the pins are driven deeper; when all are pretty firm, matted jhaumps 3 feet broad and in lengths of 10 feet, overlapping each other 6 or 9 inches, are placed streamward of the bamboo pins, and tied with string to them and to the horizontal tie, the sand, which will have been partially accumulating behind the line of pins, provided the current strikes on them at a favorable angle, will accumulate rapidly when the jhaumps have been fixed and the depth behind the Bandahl will be soon decreased, from 3 and 4, to 1 and 2 feet, as shown in the Section annexed.

7th. It will be seen that the current is thus very effectually compressed by sands formed artificially behind the Bandahls, and a stronger current is produced; if no sand forms, the Bandahls are of very little use. The sand bank will not form, if the current does not strike the Bandahl at an angle, if the current is too slack, or if the sand is very coarse.

8th. Bandahls constructed as above, will not stand early in the season, the current is too strong and the water is generally too deep; a line of very strong bamboo pins placed as close together as they can possibly be driven, and supported by ties and struts is substituted at that period, but with less effect than the regular Bandahl.

9th. The above are temporary works executed at a cost of about 10 Rupees per 100 running feet, or 1,000 Rupees per mile of river enclosed on both sides.

10th. It would be beneficial to the navigation of the river during the ensuing year, if some of the Bandahls could remain during the rains; for although submerged, the pins would in many cases suffer very little disarrangement, and would prevent shoals from forming, as the river subsides, and the necessity of another Bandahl in the dry season: I have witnessed the result, in one instance, when the river rose so rapidly and unexpectedly as to prevent a Bandahl being removed.

11th. It was necessary to renew a few pins only and the jhaumps, after the rains, this being done, the work stood and answered every purpose; but as a general rule I consider it objectionable to leave the Bandahls. Firstly, because when submerged they are very dangerous to boats passing down the river, which are so unmanageable in a high wind that, although the boatmen might be warned they could not avoid the danger. Secondly, the bed of the river changes so continually, that Bandahls, constructed as I have described, though necessary during one year, might be injurious in their effect during the next. Great experience alone and accurate local information would enable one to determine what Bandahls ought to be left standing. Thirdly, if left as permanent works, the Bandahls would in some degree cause the formation of churs and corrosion of the opposite banks, thus affecting the property of the Zemindars bordering the river by other than natural causes, and laying open the Government to complaints of injury sustained by the works of my department.

12th. The first of the objections noticed in the last paragraph will apply most forcibly to the permanent iron groins proposed by Mr. Simms for the Ganges; the large country boats would

frequently fall upon them, driven by the wind, or carried by the force of the current. The safety of a boat, frequently depends upon the boatmen being able to fend off, with their luggies, from any object in their course, but they could not thus clear a line of iron pins. The groins would be dangerous, therefore, to boats passing down the river, whilst those, which are now tracked against the stream by men walking on shore or in *shoal* water, would be obstructed altogether during the freshes, except when there was a sufficient depth of water to allow the boats to pass over the groins. These matters are likely to escape the notice of persons unacquainted with the peculiar mode of navigating the country boats.

13th. The second and third objections against permanent works, would apply only if the groins failed to produce the desired effect. Deference to the high professional attainments of the Gentleman who has suggested the plan, leads me to anticipate success from any project he advocates, but a more minute survey of the localities, than appears to have been in his power to make, would probably cause some alteration in his views.

14th. Knowing, as I do, that the current of the Ganges flows in every direction, north, east, south and west, that the deep water is generally close to one bank, as shewn in the annexed Section, and that the bed is liable to change, I should anticipate that, the current during the freshes might cut in between the groins and the bank at one end, and that, infallibly, the water would be deepened to such an extent at the other extremity of the groin, that a part of it would be carried away every year.

15th. It may be apprehended also that shoals shifted from one place, would be deposited in another. I have found that any part of the Bhaugirutty River may become obstructed: for instance, a shoal formed last year opposite the palace at Moorshedabad; I was credibly informed that the water had been deep, in that particular spot, during the memory of man: there was no apparent cause for the new formation. If then we suppose, that such changes may occur in the River Ganges between Allahabad and Buxar, a distance of above 200 miles, the expenditure of £60,000 per mile, on works, which, after all, might not secure permanent improvement, would appear unadvisable. I am myself quite unacquainted with the Ganges above Rajmahal, and cannot, therefore, offer any suggestions for the improvement of its navigation, upon which reliance can be placed. I should gladly receive any plans of those parts of the river where the great obstructions occur, when some opinion might be hazarded as to the possibility of removing them; much depends, however, upon the nature of the sand, the strength of the current and the length of the shoal.

16th. I suppose that the Bandahls used on the Nuddea Rivers, would not stand in the Ganges, but a bar similar to that below Allahabad, sketched in Mr. Simms' Report, might perhaps be removed by two converging lines of strong bamboo pins as described in paragraph 8, this might be tried; or rafts formed of grass and brushwood, floating two feet or one and half foot deep, and moored so as to increase the current, might prove beneficial. It is at any rate worth while to try what can be effected by simple works of this nature. The shoals immediately below Allahabad, are evidently caused by the waters of one river being held back by a greater flood in the other; the earth and sand carried along by the running water is then deposited and shoals are formed: but it is my firm belief that such a bar might be scoured away to a depth of 3 feet or 3 feet 6 inches by some such means as those used in the Nuddea Rivers. I believe, that the Steamers and Flats navigating the Ganges, were originally intended to draw no more than 3 feet of water, but I perceive that the *Soane* Flat, on Mr. Simms' journey from Allahabad drew 3 feet 9 inches, after leaving Mirzapore.

(Signed,) W. M. SMYTH, *Captain*,
Offg. Supg. Engr. Lower Provinces.

Memorandum upon the improvement of the Navigation of the Ganges between Allahabad and Revelgunj, by Mr. E. A. READE, C. S., *Commissioner of the Benares Division.*

Removal of obstructions between Allahabad and Revelgunj.

1st. In this paper, I propose confining my remarks to the practicability of removing the obstructions to the free Navigation of the River, throughout the extent of country above indicated.

To be treated of in three Divisions of the whole extent.

2nd. *First.* It will be convenient to treat of it in three portions. From Allahabad passing Sirsa and the River Touse to Bouroobpore, the extreme west of the Mirzapore District and the Benares Division.

Secondly. From Bouroobpore, to the conflux of the River Goomtee with the Ganges.

Thirdly. From the Goomtee to the junction of the great Surjoo or Mahadewa or Gogra, which last name had better be adhered to, to avoid confusion of it with the intermediate Surjoo.

First in order, still under enquiry. Difficulties of obtaining correct information.

3rd. Of the first portion, having learnt little or nothing, and hoping to receive shortly some precise information, I will treat last; but before considering the second portion, I would offer a few remarks on the subject of gaining good information.

Reasons of these difficulties. Mode of enquiry necessary to elicit truth. Imperfect records. Perplexing contradictions of native navigators' testimony. Why it should be so with native aptitude for remembering localities.

4th. Facts respecting navigation must be learnt afloat rather than ashore. A residence of five miles from the river side is a disadvantage. Little or nothing can be learnt on the subject from the records of the recent professional survey. The Surveyor's district maps, that of Rennell, and a map to the River Ganges from Calcutta to Allahabad, from surveys by Major Colebrooke, corrected by Captain Thomas Prinsep in 1828, are the only records I possess. The caprices of the River Ganges so to speak, render it impossible to rely permanently upon information on record, however accurate it may have been at the time. To obtain correct information is a far more difficult matter than might at first be supposed. The truth of this remark will soon be apparent to any one who will endeavour to collect facts from the crews of different native boats, regarding shoals and similar obstructions. Their diversity of evidence is beyond measure perplexing. Whether it is that their acquiescence in the yearly mutations, or even still more frequent changes in the main course of the river is so completely passive, that they dismiss from recollection any obstacles which may have impeded their progress, but which has been surmounted without peril to their craft, or whether they have for some inexplicable reason a dislike to communicate their experience, little trustworthy information is to be gained from them. They are notably apt, it is known in remembering localities with remarkable precision, even after the lapse of years; they all know well enough the exact position of peculiar dangers, such as a rock, or sunken tree, or a kunkur bed, but beyond this they are not careful to trouble their memories. Their vessel runs aground on a shoal, the difficulty is surmounted with or without assistance, and is forgotten. I cannot fix, within ten miles, the spot where one of the Company's Steamers was totally lost some years ago.

Pilots—extent and accuracy of their informaton.

5th. The Native Pilots doubtless are better informed; shoals and sands are matter of more interest to them in their vocation than to the ordinary navigators, but they have yearly to gain fresh information regarding their respective beats: the experience of the preceding year is of little avail, and I apprehend that their experimental discovery of obstructions is more frequently derived from vessels in their charge, coming in contact with them, than from any previous knowledge derived from a careful survey and continual soundings.

6th. It is then primarily necessary, as part of a scheme to remove obstructions to the free Navigation of the Ganges, to insure a continual and prompt transmission of the experiences of competent persons. For this, we must look to the Commanders of the various Steamers which ply on the Ganges. Extracts from their logs, will doubtless be cheerfully contributed. Obstructions will thus be discovered, denoted, and appreciated. These communications may be digested into a valuable and useful record, and the next step will be to turn it to good account.

Value of the records and certified statements of Commanders of Steamers.

7th. For this purpose there must be a special agency directly employed, the efficiency of which will be much augmented by the supervision, countenance, and encouragement of Government Officers, who are placed in positions which will enable them to render support to an important undertaking.

Special agency required to prosecute enquiries and digest evidence with the countenance and aid of Government Officers.

8th. I proceed to consider the obstructions, which exist between the western extreme of Mirzapore District and the Goomtee.

Nature of the obstruction between Mirzapore West and the Goomtee.

9th. Herein, as far as my experiences have assisted me, it appears that the locality of certain rocks and kunkur beds are perfectly well known to native boatmen and Captains of Steamers. They can be avoided,* and although their removal or reduction would be a great advantage, yet peculiar professional skill must be called in to estimate the cost of effecting the whole or portional reduction, and they must necessarily be reserved for future consideration. A correct record of these permanent obstructions within the Benares Division will be attempted after the recess of the Ganges, to be hereafter submitted to Government, and if necessary to be inserted in the public prints to invite attention and discussion respecting the most practicable method of effacing them. It will rest then with the Government to determine, whether it will be advisable to apply an agency, similar to that which was used in blasting and dispersing the rocks in the River Jumna, with the aids of recent scientific improvements. I only pretend to deal with obstructions of inferior character.

Rocks and kunkur beds. A complete and accurate record in course of compilation. Their treatment requiring peculiar professional skill to be applied, it will be better to reserve them for subsequent consideration.

10th. The obstructions in this portion of the Ganges are sand banks, cast up diagonally to the main course of the river. The most common are what may be called hard banks, in contradistinction to shifting sands, because the former have some pretensions to permanency, the latter have none. Of these, the most notable is a shoal below Sultanpore, and another not far from Mirzapore Cantonment. These, last year, proved a serious impediment to navigation, and in one the difficulty was overcome by a very simple process. Major Hill, Commanding the 4th Irregulars at Sultanpore, of whose experiment the public are aware, effected a passage through the obnoxious shoal by a process similar to what, if my memory serves me, is called "jobbing" in the Thames. He formed a fleet of boats in the shape of a cone, the apex down stream, and with a narrow opening between its points, at the lower side of the sand bank. At this point delvers jobbed or excavated a passage, and thus proceeded upward through the shoal. Their weapons were a common sharpened paddle secured to a stake or bamboo. The cut once made was soon widened and deepened by the operation of a known law of rivers, the superincumbent pressure of water being increased by the increased artificial depth in the first instance, and the energies of the

Hard sand banks diagonal to the main channel, the ordinary obstruction. Successful experiment of removal by Major Hill. His apparatus described and improvements suggested.

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* Perhaps I ought to make a reserve regarding the rocks near Deochupore, inspected by the Executive Officers of the Division, by orders of Government.

river, always seeking a new channel, being guided into one excavated for it. In this manner a barrier, which it would have been worth the while of the Steam Companies to remove at the cost of thousands of Rupees, was effectually disposed of at an outlay of about 27 Rupees. Major Hill's apparatus, simple as it has been represented to be, is susceptible of improvement. It could not, I understand, be moved without delay and difficulty, the delvers occasionally lost their footing and had to swim. Whether this be correct or not, is no matter. Major Hill's plan was good, and the experiment completely successful. I have attempted, in the enclosed rough Sketch of what may be called a movable Bandahl, to convey an idea of the plan which succeeded; and the additions, I would suggest, are two boats securely anchored at a distance from each external angle of the cone, with hawsers communicating to the hindermost boats: with these and a crew in each, the apparatus could be hauled up stream or allowed to drift, as necessary, while life-gaskets, or bits of rope tied to a pole, securely fixed transversely to the foremost, would enable the workmen to secure themselves from being carried away by the stream while delving and loosening the shoal. The only essential point to be observed, as a preliminary to operations, is to ascertain precisely the direction of the under current. It can always be discovered with sufficient accuracy by throwing a cylindrical piece of light wood vertically into the stream, and noting carefully the direction in which it rises to the surface.

Movable Bandahls requisite in this portion of the line.

11th. The firm sand shoals which occur in the portion of the river under consideration, it is thus argued, may be overcome by movable Bandahls with the means of delving, and the singularly small cost of such undertakings has been shewn by Major Hill's felicitous experiment.

The Bulleeah Flats,—extent, peculiarities, phenomenon, and conjectural explanations of them.

12th. We come now to the third portion in which there is an obstruction of peculiar difficulty, which may be called the Bulleeah Flats. What the natives call the Bulleeah-ka-panee, and the Commanders of Steamers, bad water, is certainly not less than sixteen miles; the stream of the Ganges throughout this extent is a race through shifting sand. It is impossible by external indications to ascertain the principal or the practicable channel. Continual sounding and slackened progress are continually defeated by the suddenness with which the drift of sand terminates. Not unfrequently the wearying process is necessary of warping the vessel over the series of shoals. The mutations too of position of these obstacles, are extraordinary, not only for their extent, but rapidity. The knowledge of the Pilot, obtained by labor and observation, is liable to be frustrated by a sudden shift of sand within the period of a few hours. There is, morever, no little danger of the vessel being surprised in the progress of those changes, of its being enveloped in accumulations of sand overmastering the exertions made to extricate it, and of thus being imbeded in a sandy prison till the river volunteers some surprising change, or the return of the rainy season floats the vessel beyond the reach of its enemy. No satisfactory explanation has, I believe, been given of this phenomenon. The natives content themselves with assigning as a reason, that a superabundance of balooh or sand is washed yearly into the Ganges, from the surface of Pergunnah Zemaneeah on its right bank, and Bulleeah on its left. The course of the river does not appear to have undergone any striking change, during the last 20 years, for on comparing Colebrooke's and Prinsep's map above alluded to, with that of the recent survey, except a recess from the town of Bulleeah and the appearance of a large alluvion called the Oomurpore Dearah, right instead of left of the main stream, as before, no variation is perceptible. There may be something in native superstition and as some assign the Bulleeah obstruction to the malignant influence of the Kurmnassa, this is not altogether unworthy of enquiry. Certain it is, that the main difficulties are between the junction of the Kurmnassa on the right, and the little Surjoo, which is believed by some to have been once the course of the great Surjoo or Gogra, on the left. I have been told that there are sunken ledges of rocks intermediate of these points, and although, from the perplexing contradictions of native testimony, I am unable to fix them, I am inclined to believe

their existence. For their existence proved, would I think in a great measure account for the peculiarity. It would be reasonable thence to infer that the river, restrained, in its under-current, by such an obstacle, when precipitated over it into a soft sandy soil, would exhibit the present peculiarities of increased rapidity in certain parts of its course, in whirlpools, eddies and shifting sands, which, separately or altogether, make the Bulleeah waters so difficult a part of the River Navigation.

13th. One of the remedies suggested to rectify this evil, is to cut a canal along the chord of the arc which represents the river's present course from Bhurowlee in the Ghazeepore District on the left bank, to Doobowlee on the right, in the Arrah District, and here it may be remarked, that the contour of the river at the Touse Flats, to be hereafter alluded to, is much the same as at those of Bulleeah, with the difference that the Surjoo and Rewah Touse enter the Ganges on the opposite sides; a similar canal in the latter case would be projected from Dum-Dumma to Barrah. But we have the great authority of Rennell against such a measure. He has shewn that wherever the soil is loose, the constant attempt of the river, in a canal, will be to assume a serpentine course. Besides the extreme probability of every season closing the mouth of the canals with sand, there is his competent authority to assume that the experiment would fail, owing to the yielding nature of the soil of the bank in which bays or cavities would be formed, which again would beget an inflection of the current to the opposite side, with the matter excavated, left in its transit, in the mid-channel, and thus supporting the stream in the similar erosion of the opposite bank with a similar result. Besides, it has been clearly shewn, that in those the least impediments are to be found, of which, by the exceeding sinuosity of the course, the stream is gentle. Diminution of the race of the Ganges on the Bulleeah Flats is the desideratum. Increased celerity by curtailment of distance would only magnify the evil.

Of remedies suggested: turning the stream by a canal either before Bulleeah or Sirsa, in the first portion of the line, controverted.

14th. The probability of securing a permanent channel by dredging, with all the advantage of scientific apparatus, and the agency of steam is, I consider, very problematical, and it would be injudicious to recommend the trial of expensive means, until simpler expedients have been attempted.

Dredging—the success problematical and the application premature.

15th. Colonel Pew, with the commendation I believe of a very competent authority, Major Boileau, has suggested the trial of a simple apparatus. I do not know a better name for it than screen Bandahls. The principle is to induce the river to assist in forming a channel, and adhering to it. The different exhibition of sands, the greater extent, and the more difficult application of means compared with the hard sand bank above treated of, renders a somewhat different process necessary. These Bandahls must necessarily be of greater length. The apparatus will consist of a fleet of boats, at some distance from each other, in two lines, with ropes to each, stakes at intervals, and hawsers passing from end to end, to which will be fastened bunches and bundles of the common Bhyr Koonta, or Palla thorn bush, which will be imbeded in the sand. The shallowness of the water will render this easily practicable. The course of the stream will have been previously ascertained, and the effect of judicious location of the lines of the Bandahl will be to induce an inflection of the current from the one to the other, so that eddies may be formed behind the screen, in which the sand will be deposited, while the current, with or without aid, clears the intermediate channel. This process it is considered will both effect a channel for, and indicate it to the navigator.

Screen or head Bandahls, proposed and described.

16th. These means are simple and inexpensive, and the perfect success which attended Major Hill's experiment last year is sufficient argument that they should be tried. I recommend their trial.

Recommendations for their use,—their small expense, and facilities of procuring materials.

The material is at hand; both sides of the river have abundance of Dinghees and Mullahs; country rope and twine, stakes or bamboos, and the thorn bushes alluded to are procurable in any quantity.

Necessity for appointing a Superintendent to be located at Bulleeah ordinarily,—his duties and occupations.

17th. But there must be a special agency, and it is important that it should be efficient; a Superintendent should be stationed at Bulleeah, to supervise, with the aid of those immediately subordinate to him, the clearing operations as the nature of the difficulty may require, and to institute a close and scientific scrutiny of the nature of the country and the peculiarities of the River Ganges and its tributaries. This is not to be gained in a trip up or down, or a mere gallop over the fields;—a series of careful levels should be taken, the variations of slope ascertained, the bed of the river should be minutely studied, especially in the vicinity of tributary streams; the existence of supposed rocks, and such permanent barriers to the free course of the river should be determined, with notice of their effects upon the current above and below.

Bulleeah preferable to other places.

18th. Bulleeah is a suitable spot for the ordinary residence of the Superintendent, because of its approximation to the principal difficulty. Dwelling-houses are available, and there is a regular post between the Tehseeldaree there and Ghazeepore; the necessary communication can thus be maintained, and, in emergency, assistance can be rendered by the district establishments, fiscal and police.

Aid to be given to the Superintendent from Government Officers.

19th. The Superintendent should be permitted to have free access to the records of the professional survey of the districts in the Benares Division, and the Sudder Board of Revenue will be able to supply him with the District maps of Ghazeepore, Benares and Mirzapore. Doubtless a map of the Shahabad District may be obtained from the Commissioner's Office of the Patna Division.

His Subordinates should be Europeans. Reasons why, and where obtainable, and what qualification particularly necessary.

20th. The immediate Subordinates should be Europeans; such men can be obtained, and replaced, if need be, with the aid of Major Stewart from Chunar. Each would have his allotted portion, his boat and crew, receiving orders from, and reporting to his superior. With their aid Bandahls will be formed where necessary for clearing operations, dangers will be noted, and information obtained. It will be primarily necessary to impress upon these men that they must consider civility to all, and especially kind treatment of the natives, their most necessary qualification. Rudeness or violence will lead to instant dismissal without appeal. This is more important than may at first sight appear. These men will come in contact with various classes of people. Much of their usefulness will depend upon enquiries and consultations. They cannot be too strongly advised to conciliate, alike, the good-will of the Captain of a Steamer, and that of the half naked native boatman. In the employment of Europeans there is too an assurance that no extortions will be attempted upon boats in transit.

Aid to be tendered by all Commanders of Steamboats to Superintendent and Overseers, and record of their communications should be kept.

21st. The Commanders of Steamers will, it may be assumed, readily give a free passage to the Superintendent up and down in his vocation, and allow his Subordinates occasionally to attach their boats when proceeding up stream. Colonel Pew, the principal member of the Ganges Company, willingly accedes to this proposal. It may be enjoined by authority on the Commanders of the Government Steamers. Much, I have hinted, depends upon free communication with these Officers. It may be presumed, that they will readily give all the information they possess, and

call attention to any obstacles they have encountered. It would be beneficial if they recorded in their logs having made such communication, and the Superintendent should be allowed to make transcripts therefrom of whatever may be useful for him to know.

To whom the Superintendent and Overseers may look for countenance, and the Government for advice and interest.

22nd. The Government have, in these two portions of the line, Officers holding positions at or near the river, who need no call to take an interest in the measures recommended. The Magistrate of Mirzapore, Major Stewart at Chunar, Colonel Pew, the Magistrate and myself for Sultanpore and Benares, the Magistrate and the Executive Officer at Ghazeepore, and Major Sherer, the Superintendent of the Stud, at Buxar.

Schedule of fixed establishment; what expenses will be contingent,—checks.

23rd. Of the proposed fixed establishment a schedule is annexed. The contingent expenses will be hire of boats and men for constructing the Bandahls. Such expenses, sanction obtained, should be generally paid by the Superintendent, and, with all accounts, may be submitted to this office for Audit and examination. A monthly report of operations should accompany the monthly account current, and, therefrom, extracts should be made, and submitted, of any thing new and interesting to Government.

In the absence of a Government Officer, Mr. Lloyd is recommended for the office of Superintendent,—proposed salary.

24th. The Government may be able to provide an Officer for the duty of Superintendent, but if not available, Colonel Pew is of opinion that a Mr. Lloyd, who has received the education of a Civil Engineer, and came out to this country, anticipating employment in the Railway undertakings, and is at Lucknow, is a competent man for the post. The salary proposed is 400 Rupees per mensem, but with the assurance on the part of Government, that, if they are satisfied with this Officer's industry and successful application of his talents, not only to the practical operations, but the scientific researches above alluded to, it should be raised to 500 Rupees per mensem.

His appointment to be preceded by examination before, and certificate from Major Boileau, Allahabad.

25th. Should the arrangements proposed meet the approval of Government, Mr. Lloyd, no other person being available, should be directed to proceed to Allahabad and to submit his professional knowledge to the examination of Major Boileau, whose report will determine the question of his appointment.

(Signed) E. A. READE,
Commissioner, Benares Division.

BENARES,
The 25th August, 1847.

SCHEDULE OF ESTABLISHMENT.

Superintendent, ...	Rs.	400	0	0		
Writer, ...	„	30	0	0		
4 Tindals at 4 Rs. each, ...	„	16	0	0		
					446	0 0
5 Europeans at 50 Rs. each, ...	„	250	0	0		
10 Tindals at 4 Rs. each, ...	„	40	0	0		
					290	0 0
						736 0 0

SIX BOATS AND CREWS.

Boat hire, ...	Rs.	5	0	0		736	0	0	
Manjee, ...	„	4	0	0					
5 Mullahs at 3 Rs. each, ...	„	15	0	0					
Oil, ...	„	1	0	0	25 0 0	150	0	0	
									886 0 0

(Signed) E. A. READE,
Commissioner, Benares Division.

BENARES,
The 25th August, 1847.

POSTSCRIPT.

The Touse Flats, as far as I am able to ascertain, present difficulties of three kinds—kunkur beds, hard sand, and shifting sand. These occur between the village of Deeha and Sirsa. The native explanation of the origin of these obstructions may not be very far from the truth, viz., that the River Ganges is more rapid than the Jumna, and carries with its stream a vast quantity of alluvial matter, that though the upper stream of the Jumna is subjugated by the Ganges, at their junction, the under-current of the former river is less affected and that its agency prevents deposit for some distance until in fact the Touse comes into the main river and checks its progress, which causes the precipitation of the alluvial matter previously kept in suspension. The kunkur bank is said to be the gift of the Touse.

The Commanders of Steamers consider these obstructions infinitely more manageable than those at the Bulleeah Flats. The peculiar impediments here presented are ever varying channels of the main stream, until the cold weather has passed, and general shallowness of water, when the river has finally settled its course for the season. The larger Steamers of Private Companies have, in consequence of this obstruction, made Mirzapore their terminus, instead of Allahabad, during the greater part of the year. The Government Steamers which require less depth of water can generally reach Allahabad, but not, I understand, without the necessity of warping over more than one shoal, in the part of the river under consideration.

Doubtless their logs, if examined, would give some more practical information, than they can be expected to communicate in reply to questions put in the bustle of landing passengers and receiving cargo. I have learnt so little from them and from enquiries amongst the native crews, that I can only recommend further enquiry. Major Boileau's residence at Allahabad, will enable him to prosecute the necessary enquiries with infinitely greater chance of success from his vicinity to the spot and his professional abilities. I doubt not his hearty consent to this division of labor.

The Schedule of establishment, however, I should observe, is fixed for the whole line from Allahabad to Revelgunge, and the Superintendent will of course make the Touse Flats the subject of his researches and freely communicate with Major Boileau. In fact, I should recommend that every record of scientific observations, prepared by the Superintendent, should be submitted to Government through Major Boileau.

(Signed) E. A. READE,
Commissioner.

No. 826.

FROM A. SHAKESPEAR, ESQUIRE,

Assistant Secretary to Government, N. W. P.

TO E. A. READE, ESQUIRE,

Commissioner of the 5th or Benares Division.

BENARES.

DATED AGRA, THE 26TH OCTOBER, 1847.

SIR,

General Department, N. W. P.

I am desired to acknowledge the receipt of your letter, dated 5th October last, and its enclosures, regarding the Navigation of the Ganges, and to convey to you the thanks of the Lieutenant Governor for the public spirit and intelligence with which you have discussed the question.

2nd. The Lieutenant Governor is disposed, generally, to concur in the opinions you have expressed, and is decidedly of opinion that, it will be advantageous to devote the season which is now commencing to the trial of the several experiments which you propose.

3rd. The Lieutenant Governor has the fullest confidence in your discretion in the conduct of these experiments, and believes that the object in view cannot be better promoted than by placing them, entirely, under your superintendence, and vesting you with full discretion to make such disbursements as you may find necessary for their conduct.

4th. The establishment, proposed in your Memorandum, amounting to 886 Rupees per mensem, more or less, may be entertained, and such further contingent charges incurred as may be necessary. The expenses will be defrayed, on your countersignature, by the Collector of Benares; monthly bills should be submitted to Government by you on the account, and will be passed.

5th. This arrangement will only extend to the end of June next, up to which period the proceedings will be entirely experimental, and the whole will then be open to revision, and such adjustment as may be found necessary.

6th. The Lieutenant Governor is unable to place at your disposal any Officer of the Army for this duty, but he authorizes you to select such agents as you prefer. It is believed that Mr. Lloyd, whom you mention, has obtained other employment which he will probably prefer. The Lieutenant Governor has reason to esteem highly that Officer's abilities as a Civil Engineer, but is disposed to to think that persons better acquainted with the language of the people, and already familiar with the river navigation might be preferable for this particular duty. The selection, however, is left entirely to yourself.

7th. The superintendence of the whole works from Allahabad to Revelgunge is placed under you, for greater convenience and management, but you are of course at liberty to call upon any Public Officer for aid who may be able and willing to render it. You can scarcely fail to find Major Boileau's advice and co-operation most valuable, and there is no doubt that it will be gladly rendered you.

A copy of the letter to Major Boileau is annexed for your information.

A copy of this letter will be forwarded direct to that Officer, and a more specific call would be made upon him for his services, were there reason to suppose that his situation or his other duties would enable him to devote his

personal attention to the subject. The Officers and establishments in the Department of Public Works will no doubt do whatever lies in their power to further the desired object.

8th. A copy of your Report and of these Orders will be sent to the Superintendent of Marine in Calcutta, in order that the Government Vessels and their Commanders may be at your disposal, so far as may be compatible with the primary duties which they have to discharge.

9th. As soon as the season draws to a close, the Lieutenant Governor hopes to receive from you a Report of your Proceedings, and such suggestions as may occur to you for future operations.

I have, &c.,
(Signed,) A. SHAKESPEAR,
Assistant Secretary to Government, N. W. P.

No. 1184.

FROM CAPTAIN W. M. SMYTH, *Engineers*,
Offg. Superintending Engineer, L. P.

TO CAPTAIN A. DALLAS,
Offg. Secy. Military Board.

BARRACKPORE, 31st JULY, 1848.

SIR,

Rivers.

I have the honor to state, that, according to the instructions contained in your office letter, No. 1444, of the 18th June 1847, I have duly informed myself, concerning the principal difficulties experienced, in navigating the Ganges; and I now beg to submit my Report thereon.

2nd. Having ascertained that the Bulleeah Reach, about 10 miles below Buxar, was considered the worst part of the river below Sirsa, I visited that place in the first instance, taking with me an establishment consisting of a Darogah, a Jemadar and a Peon, brought from the Nuddea Rivers—Upon my arrival on the 4th February, I made the annexed Sketch, No. 1, of this Shoal.

3rd. I found the current very strong, the water loaded with sand, and great uncertainty where the deep channel would finally settle for the season. The dotted line *a b* shows its position on my first arrival; three days afterwards it was changed during a strong north-westerly wind, to *a c b*, through which the *Assam* Steamer passed on the 8th February. This vessel was said to draw from 3 feet 6 inches to 3 feet 9 inches and was detained nearly twenty-four hours in forcing over the bar at C.

Extract of a letter from Mr. Lloyd to Captain Smyth, dated 6th February, 1848.

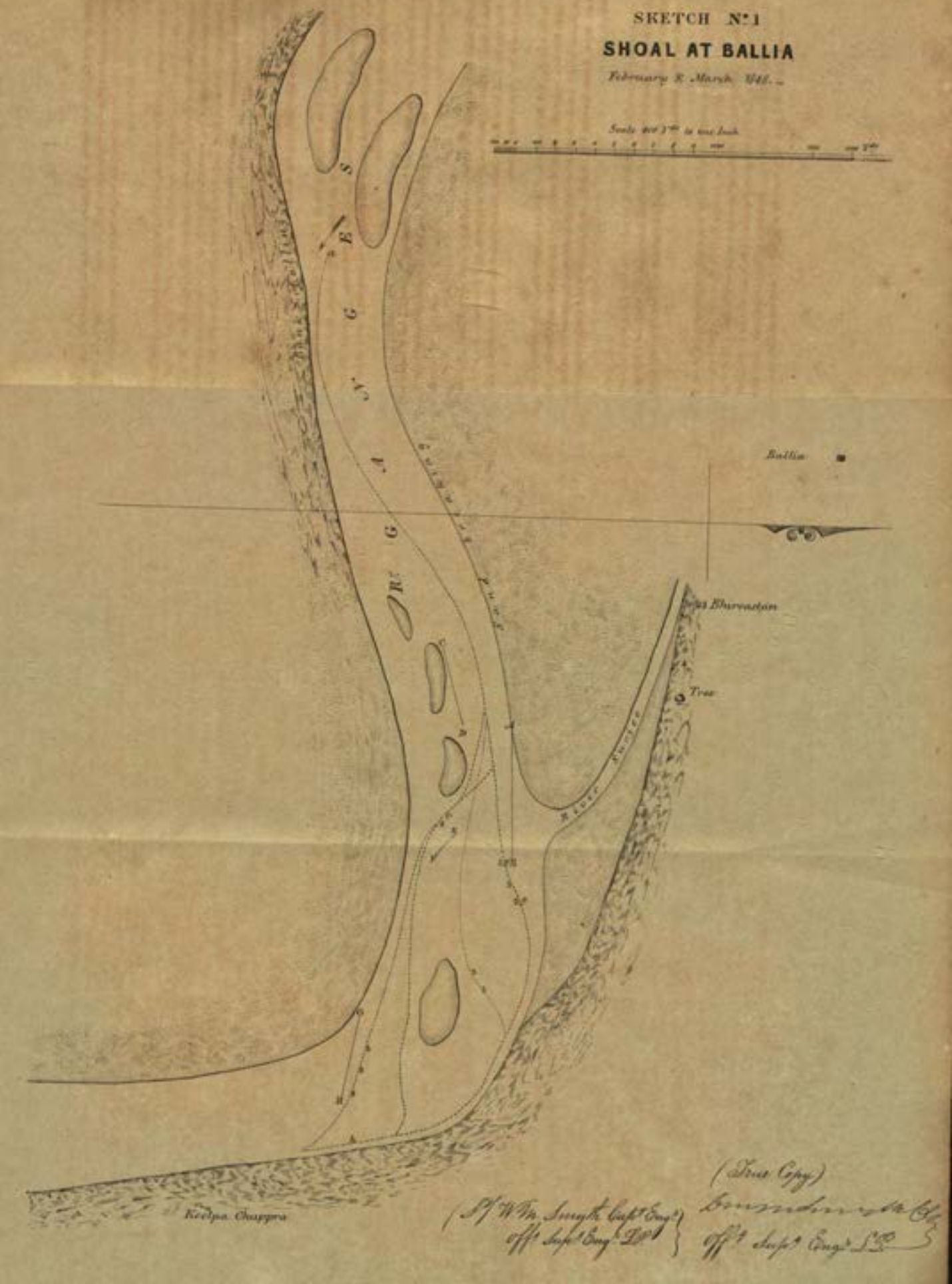
"I hear from the Overseer at Bulleeah, that there is only 3 feet "opposite the mouth of the Surjoo, from whence the water is good to "Revelgunge; but you may rely on it, that the water will very soon "deepen again; it was the Steamer *Thames* that spoilt that part of "the channel by going out of it, and falling broadside on to a sand "bank, which it entirely washed away.—The sand from the bank des- "troying the channel down below."

4th. The annexed extract from a letter addressed to me by Mr. Lloyd, assigns a reason for the shallow having formed, but subsequent observation convinced me, that the wind and falling sands, were sufficient to change the channel from one side of the river to the other.

SKETCH N°1

SHOAL AT BALLIA

February & March 1841.



(True Copy)

(Sd) W^m Smyth Capt^n Engr^s
Off^g Supt Engr Dist

Surveyor Genl &c &c
Off^g Supt Engr &c &c

5th. Finding only 3 feet depth of water, I determined at once to employ the establishment which accompanied me, and ascertain whether the stream could be retained in a particular course by Bandahls, although the extremely loose nature of the bottom (almost a quicksand) coupled with a great rapidity of current, was very discouraging.

6th. It was first necessary to collect materials, and this proving a work of time, notwithstanding the valuable assistance of the Civil authorities, I was obliged to leave Bulleeah and proceed to the Gunduck embankments, placing my Darogah under the direction of Mr. Lloyd, whom I found in that vicinity employed under the Commissioner, superintending works on the Ganges—after communication with Mr. Lloyd, it was determined to lay down Bandahls on the lines A. B. and C. D. as soon as materials should have been prepared.

7th. I again visited Bulleeah on the 9th March, proceeding up the Ganges on the *Soorma* Accommodation Boat, which left Dinapore on the 6th. The Steamer *Mahanuddee* drew from 3 feet 6 inches to 3 feet 9 inches when laden with coal, the *Soorma* about 3 feet 3 inches.

8th. The channel proved good to Revelgunge, but at this place, the Dewah or Gograh enters the Ganges, and causes shoals and an uncertainty in the position of the channel, there was a sufficient depth of water to float us, but it took two hours to find the proper track. Thence to the Bulleeah shoals, the water was good, but I observed several sunken boats and trees dangerously situated some miles above Revelgunge, and opposite Duboulie.

9th. Below Bulleeah a narrow bar of sand had formed across the channel under Koolpa Chupprah, which detained us two hours; but on my return, on the 25th March, this temporary obstruction had been carried away by the stream.

10th. At Bulleeah itself, I found the channel completely altered since my last visit, the blue line on the Sketch No. 1, shows the track on 9th March, taken by the *Soorma*. We were obliged to cross over from the left bank some distance below the Surjoo, but the water was shallow (about 3 feet in one place,) and it took us two hours to pass.

11th. On the next day, the 10th, we were obliged to separate the vessels and kedge over the shoal at C., about 200 feet long, with a depth of only 3 feet; but the bottom was so loose, that the sand was soon washed from below the boats, where they grounded, and by constantly hauling on the anchors sent out ahead, vessels drawing 3 feet 6 inches, can easily be forced through 3 feet depth of water on this loose sand.

12th. On inspecting the two lines of Bandahls A. B. and C. D., which had been laid down during my absence, I found A. B. quite useless,—the channel having left its vicinity, and a shoal having formed in its front; C. D. was also in shoal water and of little present use. Mr. Lloyd was absent, so I had not the opportunity of communicating with him.

13th. The experiment was unsatisfactory in every way, and I was obliged to order the line A. B. to be taken up, and the materials laid down on the lines E. F. G. H. in order, that I might inspect them on my return, and finally determine whether any good could be effected by their means. It proved eventually, that, when the Bandahls were constructed in 3 feet of water, and in any way opposed to the current, the whole work gave way. It would have been imprudent to drive the stakes beyond the customary depth of 3 or 4 feet, because, a deposit of sand about their base, adding,

perhaps, an additional depth of 4 feet around them, would have fixed the pins so firmly in the sand, that they would have been removed with difficulty; and a sudden rise of water might have left them dangerous obstacles to navigation, in future years.

14th. From the above causes, I fear, that Bandahls cannot be advantageously applied on the Bulleeah shoals, where the bottom is a quicksand, and the current of unusual strength.

15th. The entire bed of the river is here visibly in motion, and fresh masses of sand falling down from the crumbling banks, through which the stream meanders, and brought in clouds, from the surface of the surrounding country by the wind, supply constantly the shallows which the current as constantly propels downwards. If it were possible to protect the sand banks between Buxar and Bulleah, from erosion, the quantity of sand carried down in the stream, would be greatly diminished, and this is a palliative measure, which may be tried, and will prove partially beneficial.

16th. I shall now endeavour to point out the causes to which the shallows may be attributed.

First. A glance at Sketch No. 2, will show, that the river below Buxar, spreads over a great breadth of surface during the time of inundation; this causes the current to flow with diminished velocity, over this extended section, and to form no well defined dry-weather bed, as the waters subside after the rains, the section becomes contracted, *vide* Section i., Sketch 2, and the body of water flowing through the deep, well defined channel opposite Buxar, which may be represented by Section i., shortly arrives at the Bulleeah Flats, Section ii., over which an equal body of water must pass, in an equal time; this causes a rapidity in the current, to compensate for the shallowness of the water. The stream by its velocity would soon deepen the bed and render the river navigable, but, for the constant accession of sand, brought from the crumbling banks, and—

Secondly. The current opposite the Surjoo is very liable to change its direction, because, the Surjoo excavates a defined channel under the left bank of the Ganges below where it enters, and upon the waters subsiding, the stream of the Ganges naturally falls into this bed, but when the high north-westerly winds commence, the water is forced towards the opposite bank, and thus it varies from side to side.

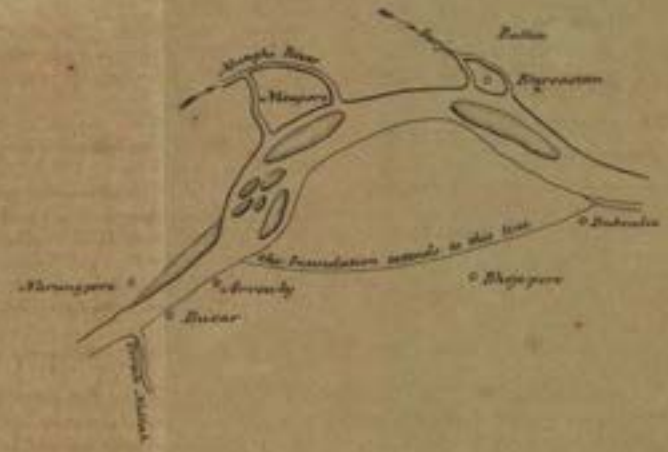
17th. The difficulty, which the native boats experience in navigating this part of the river, is caused, rather, by the strength of the stream and nature of the bottom, than by the want of water. It rarely happens, that in the course of a few days, a channel does not open in which there is a depth of 3 feet 6 inches; but I understand, that boats are sometimes detained above a week, awaiting a fair wind to stem the current.

18th. The detention of Steamers at Bulleeah, is not unattended with danger to the large vessels belonging to Private Companies, which are liable to be strained in forcing through the shallows; but the Government Steamers, which draw from 3 feet to 3 feet 6 inches, seldom lose more than a day or two, and therefore, extensive works for fixing the channel, are not advisable, if considered purely as a question of profit and loss to Government.

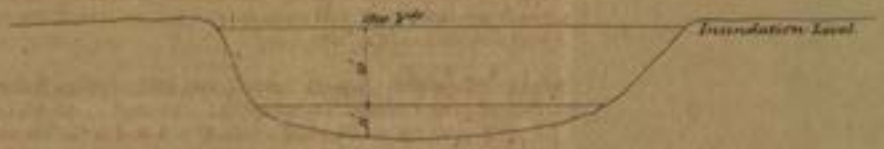
19th. But varying as the channel does, it is desirable, that a native pilot should be stationed on the shoal. The ordinary river pilots, who accompany the Steamers for various distances, cannot be acquainted with the changes which occur during their absence, on such a shoal as Bulleeah; and it is not to be expected that the Pension Serjeants, who have been posted on some of the shoals, can expose

N°. 2

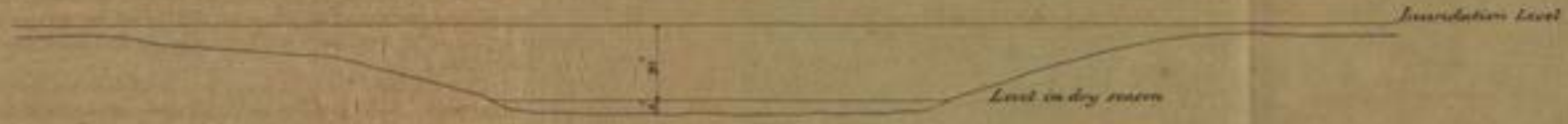
SKETCH of the BALLIA REACH
according to RENNELL shewing the great spread of the Inundation below Buxar



Section I. Shewing the supposed breadth & depth opposite Buxar.



Section II as below Buxar near Ballia.



Scale of Miles for the Plan. yards for the Sections & feet for the Elevation

(Sd) W. M. Smyth Capt. Engr
off. Asst. Engr. L.P.

(True Copy)
W. M. Smyth Capt. Engr
off. Asst. Engr. L.P.

№ 3.

Eye Sketch of the Sheat below Ghazepore

not Surveyed

March 1841

№ 4

A B. Shews a line for a **BANDHAL** which would have probably removed this Sheat..

Eye Sketch of the Sheat below Mirzapore

not Surveyed

March 1841

(Sd) Wm. Smyth Capt.
Offg Supt Engr D P

(True Copy)
Offg Supt Engr D P

themselves to the extreme heat of the weather in the dry months. The Europeans who were employed last year in marking off the channel, suffered very much in health.

20th. On my return to Bulleeah on 25th March there was a good channel, as marked by the red line, through which the Accommodation Boat passed without difficulty, after having been detained many hours, whilst the Steamer was forcing a passage down the channel marked in blue, formerly navigable, but then closing. Had the Steamer been directed along the proper channel marked by the red line, we should have experienced no detention whatever on this shoal, on our downward trip.

21st. As connected with the shoals at Bulleeah, I have annexed a letter from Mr. Lloyd, descriptive of the works he had undertaken in that vicinity. I very much doubt, whether they were beneficial both from what I learned on enquiry from the Commanders of the Steam Vessels, from my own observations, and from what Mr. Lloyd himself told me; I must except, however, the removal of a mud bank below Buxar, cut through by manual labor.

22nd. Leaving Bulleeah, we proceeded on the morning of the 11th and grounded for a short time at Mausarea, below Buxar.

23rd. On the 12th March, we grounded about 3 miles below Ghazeepore (Sketch 3,) and were detained above three hours; the current is here slack, the bottom sandy, and it is probable, that this shoal might be removed by Bandahls; but there is a difficulty in procuring materials, and from the breadth of the river, such works would be expensive. At Ghazeepore, I went on board the *Sutledge* Accommodation Boat, the Steamer attached to it draws 6 inches less than the *Mahanuddee*, and it is said, will be able to reach Allahabad; the other cannot proceed beyond Seersa.

24th. We left Ghazeepore 2½ P. M., and passed the Rocks at Barrea. It may be remembered, that in 1839, expensive works were proposed for improving a channel in this vicinity, under the direction of the Executive Engineer at Ghazeepore, but a subsequent change in the course of the river rendered the work unnecessary, the dry weather channel is still remote from the dangers which were to have been removed, and this shows, how much money would be uselessly expended, if works were inconsiderately undertaken.

25th. During the last few years, dangerous kunkur rocks have appeared near Deochempore, but here again, a new passage has this year opened through the sand, and they are now avoided.

26th. At Chandroutee, 4 miles above the mouth of the Goomty, there is a rock, said to have been very dangerously situated last year, but not complained of during the present.

27th. It is obvious, that any extensive works, for removing kunkur rocks between Ghazeepore and Benares, may be rendered useless by the changes that constantly occur in the dry weather channel, nevertheless, obstructions of limited extent, such as an insulated kunkur rock similar to what I suppose to be at Chandroutee, ought to be removed; and the Commanders of Steamers might report upon any such obstruction to the Executive Engineer at Ghazeepore, who being conveniently placed, could readily remove it by blasting, or other means.

28th. *March 13th.* Arrived at Benares at 4½ P. M., having grazed a sand shoal, over which there was only 3 feet depth of water.

29th. *March 14th.* Reached Mirzapore at 5 P. M.; a European Pensioner piloted our boats over a shoal below Mirzapore, Sketch No. 4, where there was 3 feet of water; he had some men employed, deepening it with kodalies. This shoal detained us some hours on our downward trip; judging from the appearance, Bandahls would have removed it.

30th. *March 15th.* Leave Mirzapore at 6½ A. M., arrive at Seersa in the evening.

31st. *March 16th.* Grounded below Dum-Dum; only 2 feet 9 inches of water, bottom rather muddy, current slack, shoal as sketched (No. 5.) We forced a way through this shoal in about three hours, and reached within a mile of Allahabad at 2½ P. M. Annexed (No. 6,) is a sketch of the shoal below Allahabad.

32nd. *Monday, March 20th.* Leave Allahabad at sunrise; the wind very strong, and we were consequently detained, as the boats could not be kept in the narrow channel. In passing up, we had taken the channel marked *h*, (Sketch No. 6;) but it had been obstructed by the falling of the sand at *a. a. a.* and a strong westerly wind forced the water through the channels *c. d. b.* and *e. f.* We passed through *b.* with difficulty and detention. In this reach, where, the diminished breadth of the river, the more moderate current, and the firmer nature of the bed, are favorable for operations, I see no reason to doubt, that Bandahls, which failed at Bulleeah, might here produce excellent effect. If the line *c. d. e. f.*, Sketch No. 6, had been fixed, either *b*, would have been deepened or otherwise by closing *b.* also, the right bank channel *h.* would have again opened, and the obstructions in that track would have been removed. It would have been proper also to protect the falling bank *a. a.* from the erosion of the stream.

33rd. Native boats navigate this part of the river* with difficulty in the dry season, when it shoals in places to 2 feet 6 inches. I have no hesitation, therefore, in recommending, that measures should be undertaken for improving the navigation, which would so much facilitate the traffic of the country, carried on, for the most part, in native boats. The waters seem manageable and susceptible of being restrained in a particular course, which would eventually ensure a good open channel.

34th. *March 21st.* After much labor, the Steamer was got afloat, and we passed to the shoal at Dum-Dum, before described, (Sketch No. 5). We arrived at 10 A. M., but were detained till the evening. The channel had changed from *b.* as I had anticipated that it would do; it now hugged the right bank to the point at which the Touse River enters into the Ganges. If the channels *a. a.* and *b.* had been closed, the depth in the right one *c.* would have been proportionately increased, and a depth of at least 3 feet water might have been secured.

35th. Materials well adapted for constructing Bandahls are not procurable at Allahabad, but with timely notice, a sufficient supply of small bamboos can be purchased; and if supported by a proportion of saul bullees, or other wooden posts, would doubtless answer the purpose.

36th. The mode of constructing Bandahls, and their effect, has been before described by me; but Captain Lang's Report, forwarded with my No. 1108 of the 27th July 1848, contains a more recent, and a very full and clear account of the works used with effect on the Nuddea Rivers, and which, I think, might be successfully employed on the upper parts of the Ganges. The works could be eventually extended, if they proved beneficial. The advanced season when I visited Allahabad and the want of materials, prevented any attempts being undertaken last year, to improve the channel of the river between that place and Seersa, according to my original intention.

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* That is between Allahabad and Seersa.

№5

Eye Sketch of the Shoal at Dum Dumma above Seersa

not Surveyed

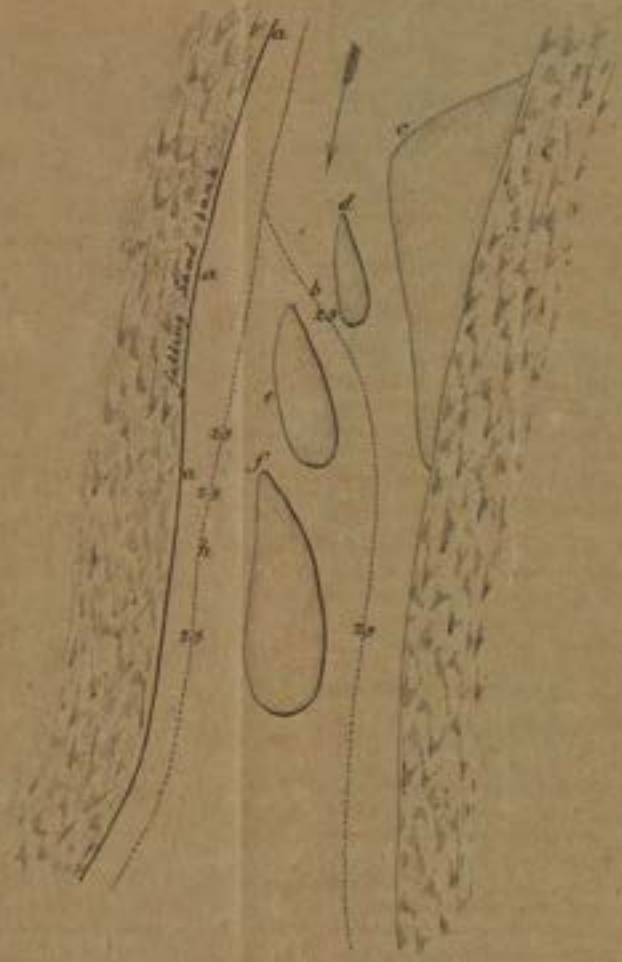
(Sd/ W. M. Smyth Capt. Engr
Offg Supt Engr L.P.

(True Copy)

March 1828

Offg Supt Engr L.P.

№ 6.



Eye Sketch of the Sheal below Allahabad

not Surveyed

/ J.T. W. Medwright Lieut. Engr
Offg Supt Engr I P

/ True Copy March 1841
for pro. Secy to Govt
Offg Supt Engr I P

37th. *March 22nd.* Returned to Mirzapore, observed the rock above that station said to be dangerous; but the position is well known, and there seems to be no difficulty in avoiding it, therefore, the removal of so large a mass of stone, is unadvisable.

38th. Sunken trees lie dangerously situated in the channel of the river, 30 miles above Mirzapore, off Patoolia Ghat, at Daboulie, below Bulleeah, and also between that place and Revelgunge. To prevent these obstructions, it is important, that all trees likely to fall into the river, should be removed from the banks; but the religious prejudices of the native landholders, make them unwilling to fell the bhur and peepul trees: the Collector could, however, instruct his Officers to see the necessary measure carried out, if the Commanders of Steamers communicated officially to him, where trees, requiring removal, were situated.

39th. Trees and wrecked boats should be removed from the channel of the river by an establishment entertained for the purpose. A strong country boat fitted up with a capstan, should be manned by persons instructed to fire a blast of powder in the trunks of trees, or other obstacles; there should also be a couple of divers for working under water. A diving helmet or other like apparatus, would be also useful, and the boat should proceed on its duty after the rains, under the immediate charge of a steady, intelligent Overseer.

40th. The services of an experienced Officer to direct the works, which I have suggested, would be valuable, but if none such be available, the operations might be carried on during next year, most economically, under the Executive Engineer at Allahabad, if an Assistant, with an adequate staff salary and who could survey, were placed under his orders. The experimental works proposed for deepening the channel lie in the vicinity of Allahabad, whence they could be easily inspected.

41st. The Assistant could make accurate surveys of the shoals thence to Bulleeah, at the commencement of the dry season; and also in March, they should be compared together, and with my description of them, during the present year.

42nd. With this information, and the report of the Superintending Engineer, Central Provinces, on the effect of the Bandahls between Allahabad and Seersa, sufficient information will have been collected, to enable the Board and Government to decide on the nature and extent of works to be undertaken hereafter for facilitating the navigation of the Ganges. If it be decided, that the works I have recommended, shall be carried on next season below Allahabad, materials, such as bamboos, posts, mats and jhow bushes, should be collected; a Darogah from the Nuddea Rivers should be detached so as to reach Allahabad by the first week in November, and the operations could commence when required in December or January. I have no doubt, that, Major A. H. E. Boileau, Superintending Engineer at Allahabad, would direct the rigging up and manning of a suitable wreck-boat for removing trees, &c.

43rd. There are upwards of 3,000 Rupees unexpended from the grant of 5,000 Rupees made last year by the Government, for works on the Ganges, and which would suffice for the experimental Bandahls.

I have, &c.,

(Signed,) W. M. SMYTH, *Capt. Engrs.*,
Offg. Supg. Engr., L. P.

(True Copy)

(Signed,) W. M. SMYTH, *Capt.*,
Offg. Supg. Engr., L. P.

No. 27.

FROM E. A. READE, ESQ.,

Commissioner 5th Division.

TO C. ALLEN, ESQ.,

Offg. Secy. to the Govt., N. W. P.

AGRA,

DATED BENARES, THE 10TH OCTOBER, 1848.

SIR,

Ganges Navigation.

As directed in paragraph 9, of Mr. Shakespear's letter, No. 826, dated 26th October last, I have the honor to submit my report on the navigation of the Ganges, and the removal of obstructions therein.

2nd. It will be proper to notice, first, the measures taken to ascertain the extent of traffic up and down the river, conformably to the directions contained in His Honor's Minute, dated 12th June 1847.

3rd. Finding it impossible to obtain trustworthy information without the employment of a special agency, under the sanction of the Government order above referred to, I intrusted the duty of compiling a register of boats of burden passing Ghazeepore, up and down stream, to one of my clerks, a substitute performing his official duties. With the permission of the Rajah of Benares he and his assistants, afforded by the Collector of Ghazeepore, were allowed to occupy an upper-roomed house, overhanging the river. From before dawn and until nightfall, the look out was carefully maintained, and the requisite entries made in a daily register, during the whole term from 1st July 1847 to 30th June 1848.

4th. The nature of this register from which the quarterly and yearly returns, herewith transmitted, are compiled, will be best understood by referring to the instructions given regarding it. It contains particulars which, incidentally, enabled me, with other helps, to test the accuracy of the weekly registers compiled from it and regularly sent to me. The fluctuations apparent according to the direction of the wind, have been noted. The names of, and dates of passing of Steamers have been also carefully registered, and I have in no one instance on enquiry from the Commanders, with whom I have had a good deal of intercourse, been able to detect an error or omission. Nor have the results of occasional inspection on certain dates in the vicinity of Benares, exhibited much variation, except in uncertain weather. I believe the returns, Index A, are faithful, and approximations to truth.

5th. It will be seen from these returns that the traffic up stream is principally in the second quarter, down stream in the third quarter of the Christian year, and that the average number of native craft of burden passing up and down stream before Ghazeepore is 13,381, with a tonnage of 1,04,62,300 maunds, during the year. To which will be added 147 steamers and 148 passenger boats passing. Total of all craft of burden 13,676.

6th. Even if a much milder schedule were adopted than that appended to Regulation VIII., 1824, these statements show that a considerable sum would be raised by imposition of a moderate toll on boats both laden and unladen, for the present statements give no specification, and for this reason that the Inspector and his assistants were imperatively forbidden to visit any boat. It was not

considered a matter of much importance whether the passing boat was laden or empty. The estimated tonnage was reckoned by the eye and the aid of a telescope. From what I observed myself, I conclude that the tonnage has been rather under, than overrated.

7th. In taking leave of this part of the subject, and in allusion to the imposition of a toll, I cannot forbear making the remark that the advocacy in paragraph 14 of my last report, for the adoption of simple means for removing obstructions at first, in preference to expensive machinery, and the inducement which has prompted me to aid exertions, with all the help I could give them, has been this; peradventure taxation and its evils might be obviated.

8th. I propose now to give first, a brief sketch of the plan of operations, which was as follows: To divide the whole line into three divisions of superintendence, commencing from Revelgunge. The first, from Revelgunge to the Goomtee. The second, from the Goomtee to the boundary of the Mirzapore and Allahabad districts. The third, from the point last mentioned to Allahabad. The first division, with reference to the peculiar difficulty of the Bulleeah race, to be the joint charge of the Collector of Ghazeepore and myself, aided by a practical Engineer. The second, under Major Stewart, Superintendent of the family domains of the Rajah of Benares, aided by the Collectors of Benares and Mirzapore and Colonel Pew, during that officer's sojourn* at Sultanpore. The third, under Major Boileau, Superintending Engineer, Central Provinces.

9th. The latter Officer, owing to the pressure of his official duties, was unable to aid us in person, and with little exception, this remark applies to the other functionaries above named. But he aided us liberally with useful suggestions, which will be found with the enclosures of this letter, and which have been followed, as far as practicable, with the means at our disposal. So far, therefore, as regards actual personal supervision of operations on the river, this has been confined to Major Stewart and myself.

10th. The Engineer appointed to devise and superintend the works, Mr. Lloyd, recommended by Colonel Pew, and pronounced duly qualified, after examination, by Major Boileau, had received the requisite education for, and some considerable experience in various branches of Civil Engineering. It should be mentioned that his relative, Colonel Lloyd, desirous he should do well in his new duty, placed a pinnace and crew at his disposal. From the invalid pensioners at Chunar, of whom several are in the prime of life, though unable from wounds to discharge the duties of their profession, Major Stewart's selection, as the result afterwards showed, was judicious, and to each was allotted a portion of the river, from Revelgunge to Sirsa near the River Touse and Allahabad.

With one exception, all did good service, and the exception was disabled by sickness.

11th. The first operation was to mark off dangerous places, rocks, or kunker beds, sunken boats and trees. Poles with cross pieces were firmly fixed at all such places. The next was to mark off the main channel in all doubtful parts of the river, which was similarly done by erecting bamboos on the *left* side of the current, in order to save the expense of double series of poles. This was of course done with rapidity and ease.

12th. The next operation was against hard shoals formed diagonal to the stream, which, here and there, last year, caused so much detention, and it will be remembered, was, in one instance, at Sultanpore, successfully disposed of by Major Hill. This species of obstruction, we found had been much overrated. There was no necessity to apply the cumbrous and expensive machinery of a

* November to March.

number of hired dinghies. Nothing could be more simple than the process that was tried. First, by careful soundings, the breadth of the shoal from deep water, on either side, was ascertained, and a double row of poles, about 12 feet apart and from each other on each side, was erected, and a cross rope tied from one side to the other. In the intervening space, the sand was disturbed by rakes, or paddles, and latterly by an implement invented by one of the Overseers, something between a hoe and a spoon, (which was very effective, as it lifted as well as disturbed,) till a cut was made across the shoal. In a single night, sometimes the channel was completed by the action of the river, and within a week, scarcely a vestige of the shoal remained.

13th. In the early part of December, the course was clear, the main channel for navigation was either obvious with the usual aid of sounding, or indicated by marks in intricate places, and the only difficulties encountered were these—The crews of the native crafts, coming down the river, took no pains to keep them from running foul of the stakes, in fact they purposely uprooted and carried off the best. The Native Mullah's notions of jetson and flotson, are most peculiarly licentious. It was thought advisable, therefore, to *paint* the stakes, to substitute in some places the common gourd as a float, and these also it was necessary to subject to the same process, for even they were pilfered; and in making up the rope required for the works, to introduce a coloured strand for the purpose of future recognition. The greatest difficulty was with the Native Pilots, who took it into their heads that their occupation was gone, and whom it was not possible for a long time to conciliate. This class of men from Bulleeah upwards, are inferior to those engaged below. Dinapore Mullahs, for some reason, like Dacca boatmen, have a much better repute than the tribe elsewhere has on the river. The others are under little control, are irregularly paid, more or less addicted to liquor, and several of them affected with the peculiar malady of night-blindness. There are exceptions of course, but generally they are very inefficient. In some parts of the river, their beats are too long for them to have a continually correct knowledge of channels liable to continual variation by shifting sands. In others, their employment is a mere matter of form. The Commander of the Steamers could do as well, or better, without their assistance. There cannot be much hope of improvement of this agency, while the selection is left to the Ghat Manjees.

Mr. Lloyd's description of these persons, is not overcharged. In 9 cases out of 10, they make no previous survey or soundings, but pilot the Steamers from observations of the course of country boats ahead.

14th. As the season advanced, difficulties of course increased, and I now beg to draw His Honor's attention to Mr. Lloyd's Report with the enclosures of this letter. I have preferred submitting it, as I received it, because it is honest, and in many parts of it, contains good practical information. Excuses will be received for defects in style, composition and arrangement, when it is considered the author is rather accustomed and adapted to work himself and superintend the work of others in Engineering operations, and to regard the pen with least favor as an implement of his art. I have abstracted Mr. Lloyd's paper in the margin, in paragraphs, and marked those passages which most deserve attention.

15th. The first great difficulty which was not foreseen was a new, at least a very unusual obstruction,* the formation of *mud banks*. Of these the worst was near Buxar. Major Stewart's explanation of this, which is certainly a phenomenon, is probably correct. Last year the inundation was unusually high, and also late in the year; in consequence the quantity of surface soil washed into the river must have been unusually great. Close to Chunar, where the operation of removing a strip of one of these formations took place under my own eye, I had an opportunity of witnessing

* Between Allahabad and Bulleeah.

myself, the great difficulty of the work of removal. The disposal of a mere sand shoal is comparatively trifling, for the sand, disturbed by the process, is held for some time in suspension, and carried forward by the current. But the agency of the latter had little effect with adhesive mud. Its removal altogether, in small quantities, was of little avail, for the mass on either side subsided gradually into the space excavated. Paras. 34 and 35 of Mr. Lloyd's Report, give an interesting exposition of the means and contrivances resorted to, for the removal of the mud bank above referred to, which were in the end completely successful.

16th. The mud bank in question was the only one that was formed across the river, so as entirely for some time to prevent the navigation even of common country boats. Elsewhere, they were more practicable. When they interfered so as to narrow but not altogether obstruct the channel, they were curtailed by dint of labor, and for the last three months gave no further trouble.

17th. It was otherwise with sandy shoals, removed, as I have before shewn, with comparative ease. But though it may not be strictly correct to say that they re-appeared in different places, yet it is certain that similar obstructions were exhibited in parts of the river further down, when they were least expected, these of course had to be disposed of in the same manner.

18th. These, however, were minor difficulties compared with the Bulleeah Flats, to which Mr. Lloyd devoted his principal exertions, and wherein he was for some time assisted by Captain Smyth of the Engineers. Paras. 11, 12, 26, 27, 28, 31, 32 and 33 of his Report relate to the measures adopted by himself and Assistants as circumstances suggested.

19th. The sketch map, the first in the series, will, I think, convey, better than any description, an idea of this very formidable difficulty. The peculiarity of the river at Bulleeah, is, I think, correctly shown by Mr. Lloyd, whose remarks, from my own observation, I believe to be correct. It is owing to the loose soil of the margin of the river in this part of the valley of the Ganges, by which the river is annually choked up, its general depth diminished and the force of its current proportionately increased according to the known law of rivers. After all that has been said in theory as to the Bulleeah race, the common native explanation given above is the simple and rational one, that it is owing to the quantity of sandy soil yearly washed into the river, and that in those seasons when little rain has fallen, and inundation has been partial, the Bulleeah waters are most practicable.

20th. Mr. Lloyd's operations, as he faithfully describes them, were partial successes and frequent failures. He argues that the former would have been more complete, and the latter obviated in a great measure by incurring greater expense. He may be correct. But my own opinion is, after a very careful consideration of the numerous reports received from the Superintendent and his Assistants, from observations on the spot, and continued consultations during the season with Commanders of Steamers, and manjees of native crafts, that the application of very expensive means even will not suffice, always, to maintain a clear channel.

21st. The Bandahls have in many instances been, and in ordinary places will be perfectly successful. There has been no lack of industry and ingenuity in using them and other means, the stopping up of blind channels, and the like devices, for urging the main stream of the river into the uniform course. But there are these impediments to complete success, which I consider insuperable.

First. That the bed of the river is affected as the waters above are, by any increase or change of wind.

Second. That the grounding of a Steamer or large vessel in the upper part of the river is quite sufficient to nullify the measures taken for the clearance of the channel below.

Third. That the Steamers have been and will be the greatest impediments to any continually successful operations against *quicksands* of any extent.

22nd. In going up the river there is comparatively little risk of running aground so as to stick fast for any time, with a cautious Commander, determined to know his course before he proceeds. The channel, vary as it will, must be somewhere, and to find it and thread its course is the difficulty. But in coming down stream, it is impossible in narrow places with sharp turnings, especially with the larger vessels, to bring them round always in sufficient time. Hence the shoal to be avoided receives the vessel, and before it can be warped out of it or over it, which is usually attempted, a primary mischievous derangement is originated, which extends its influence more or less, according to circumstances, through the whole extent of the line of operations.

23rd. The large Steamers of the Private Companies, I have carefully noted, occasionally in the upward and more commonly in their downward course have, not so much by requiring greater depth of water as greater space for movements, continually thwarted the operations for keeping one distinct channel open. Again and again the weekly reports have furnished corroboration of this fact.

24th. The channel of the River Ganges, through the Bulleeah Flats, by the use of any means and appliances, if it could be kept clear, could not be rendered broad or straight. It could only be narrow and tortuous. Practicable navigation under such circumstances, therefore, resolves itself into a simple proposition. Given,—the length of the vessel and the force of the current;—the requirement is, sufficient space in the channel for the vessel to steer in any direction;—and this, with any hope of certainty, I consider cannot be obtained.

25th. On the subject of operations between Chunar and Allahabad, Mr. Lloyd has not considered it necessary to enter into detail, with these he was comparatively but little engaged. He has alluded to the Bhuttowlee Flat in Para. 6 of his Report, and his description of it is correct.

26th. In February, this portion of the river became wholly impassable for the large Steamers, and it was found necessary to employ two Overseers, one of whom had been working under Mr. Lloyd at Bulleeah and had acquired some experience. The stream we found comparatively sluggish and flowing in several channels. The plan adopted was to close, the entrance of all the channels but one, and by continual delving to assist the action of the river on that which was reserved: after three weeks' labour a practicable channel of four feet water through the whole length was found, which did not undergo any sensible change. The Steamers were enabled to pass up and down with caution, and as the season advanced, it continued to improve, and no further difficulty was experienced. I did not think it expedient to allow any experimental use of Bandahls, suggested by Mr. Lloyd, for deepening the channel, as the necessity was not urgent, and it has been my object to avoid unnecessary expense as much as possible. Subsequently as the Bhuttowlee obstruction diminished, the shoal a little below the Mirzapore Cantonment, which last year was as grievous an obstruction as that near Sultanpore, became troublesome, and to it Mr. Lloyd applied the remedy he recommended for Bhuttowlee as shewn in the Sketch Map, No. 10. First a narrow channel was delved, and the main body of the stream converged by two Bandahls, one below an upper one which closed the mouth of an useless branch of the river. The last mentioned was left in its position as calculated to assist, hereafter, in forming a barrier against the river escaping by any but the legitimate course, which was by the operation rendered good in the course of a few days.

27th. Between Mirzapore and Allahabad, as far as Sirsa, little was done but to mark off the channel, to cut off the edge of obtrusive sand shoals, and to note dangerous places. Mr. Lloyd has remarked in Para. 17 of his Report, that the kunker beds would serve as fixed points from which it would be comparatively easy to improve the channel, and his observation is doubtless correct. But by the testimony of Commanders of Steamers of the Honorable Company, and those of Private Companies not proceeding beyond Mirzapore, it was clear that this portion of the river in the past season was better than usual. I thought it unadvisable to attempt any operations on kunker beds, without professional experience on the spot. The Overseer therefore was instructed to confine himself to the simple operations described above, and on completion of them his further services were dispensed with.

28th. The same course was pursued with regard to the other establishments. As the necessity for further operations no longer existed, they were paid up and discharged, Mr. Lloyd's services only having been retained till June.

29th. Having thus given a cursory review of the principal operations of the season, I beg leave to offer the following opinions and suggestions. My judgment has been much assisted by the remarks of Captain Smyth formed during a tour of observation, which I have been permitted to peruse, and which will be found with the enclosures of this letter, together with valuable papers from the Superintending Engineer, and reports from the Magistrates of Benares, Ghazeepore and Mirzapore.

30th. I can only express an opinion, with any degree of confidence, and even then with the natural distrust of a non-professional person, as regards the portion of the river between Revelgunge and Mirzapore.

31st. I do not think any necessity exists for the retention of a special establishment, *permanently*, for removing obstructions in this part of the river I do not think it possible for any professional skill to overcome the difficulties of the Bulleeah race, even with most expensive means. For if experience should induce the proprietors of the large Steamers to employ a smaller class of vessels for the navigation of the Ganges (as Captain Smyth anticipates) above Dinapore, it would be impossible to provide against occasional mishaps and detentions in all contingencies of season. Captain Smyth's suggestion that the Pilot boats should be reduced in length, so as to enable them to acquire ready knowledge of every change in the course of the river, is, I think, the best measure that can be adopted.

32nd. In this he has the concurrence of the Commanders of Steamers, whom I have consulted, and native boatmen* whom I have employed myself on this part of the river. But it is hopeless to expect any amelioration without some better regulation as to Pilots. I think an effective establishment, with a head Pilot, might be maintained under the orders and charge of the Tehseeldar of Bulleeah. The present incumbent of that office can read and write English, and is continually called on to assist in releasing Steamers from difficulty. Blank forms might be supplied, through him, to the Pilots, in which the Commander of the Steamer should certify as to safe pilotage or otherwise through the beat, and under all circumstances pay the fixed charge. The Tehseeldar would then have a voucher for the payment of the whole or a moiety of the fixed compensation in case of failure to the Pilot himself, endorsing the sum actually paid on the certificate. The certificates with a memorandum might be sent half-yearly to the Collector's office. Each Pilot would of course have his name and number on his badge.

* The task of procuring the timber for the College here has fallen on me. Its boats have at different times come from Goruckpore. I have learnt much from the observations of the manjees.

33rd. Between Bulleeah and Mirzapore there may again and doubtless will be shoals formed inferior to, but like those of Sultanpore and near Mirzapore Cantonment. The Commanders of Steamers can report them at the nearest station to the Magistrate or to this office. The *modus operandi* is so simple, and is *now* so well known, that immediate steps could be taken against any such shoal by a few mullahs under a Thannah Burkundaze. Should Sultanpore or the Mirzapore or other shoals, which are usually notable obstructions of the kind, seem to require a superior agency, the Overseers whom Mr. Lloyd has indoctrinated are at Chuñar, and will readily undertake the job.

34th. The Bhuttowlee Flats will always be a difficulty in January and February; probably it may be necessary to have a party employed there during those months, for conducting simple, but sufficiently effective operations there, as in the past year,—to wit, the closing of minor channels, and thus inducing the main body of the river water adhering to one course gradually to deepen it.

35th. Above Mirzapore or between that place and Allahabad, the work to be accomplished is not the removal of occasional obstructions, so much as a general widening and deepening of the channel for considerable distances. This is an undertaking that professional experience only can appreciate and provide for. I can only state that if the Government adopt Captain Smyth's suggestion, Mr. Lloyd, I have no doubt, will do justice to it. He is still at Benares.

36th. But I must remark that there are besides ordinary obstructions, *dangers* in the River Navigation, to which I would beg leave to draw attention. They are the subject of Paras. 18 to 25 of Mr. Lloyd's Report. Experience has shown, that if a Lighthouse were erected on rocks or kunker beds in mid-channel, such is the apathy or awkwardness of native boatmen that, yearly, boats will continue to be broken upon them. I perfectly concur with Mr. Lloyd in the imprudence of meddling with such formations connected with either margin of the river, but in mid-channel I would earnestly advocate their removal, when sappers and miners can be spared for such work.

37th. Mr. Lloyd's plan for removal of sunken trees is, I dare say, practicable, and not greatly expensive. I did not sanction these operations during the past year, for these reasons, that I found it would be necessary to hire the largest description of native boats, and the owners of such boats in every instance most positively refused to let out their boats for any such purpose. It would be necessary to purchase or build two boats, such as Mr. Lloyd describes in Para. 25 for this work, and I did not consider myself warranted to go to this expense.

38th. Appended to this report is also a memorandum of payments made from the Collectorates of Ghazeepore and Mirzapore, under my orders, and for which I stand charged, by transfer, in the Benares Collectorate Treasury accounts, from which this is an extract. Every item of a miscellaneous expenditure has been passed by me after due scrutiny and it will be seen that the cost of the Inspector's establishment at Ghazeepore is included in the sum total of Rupees 7,175-13-4, which includes all expenses chargeable to Government. The proceeds of sale of the material in store at Bulleeah and Mirzapore will, when realized, be brought to credit in the accounts of the Benares collectorate.

I have, &c.,

(Signed) E. A. READE, *Commissioner.*

COMMISSIONER'S OFFICE, 5TH DIVISION,
BENARES,
The 10th October, 1848.

Reporting the result of the Operations for the Improvement of the Ganges.

FROM SUPERINTENDENT, *Ganges Works.*

TO COMMISSIONER, *5th Division.*

DATED, BENARES, ——JUNE 1848.

SIR,

1st. The following observations are principally embodied from the various weekly Reports, &c., sent in for your information during the past season; and I now proceed, previous to treating of the different improvements effected, to offer a few remarks on that portion of the River Ganges lying between Allahabad and Revelgunge.

Remarks on the River Ganges between Allahabad and Revelgunge.

2nd. The worst places on the river are at Revelgunge, Bulleeah Flats, Bhuttowlee and Sirsa. There are many intermediate places where the steamers are detained occasionally, as at Deochundpore, Sherpore, Dumdumma, a shoal below the cantonments of Mirzapore at Mouzah Balliperwah, &c. But the above are the principal difficulties and it is at these places that the Steamers and Native crafts are generally delayed.

Names of places where there are worst obstructions.

3rd. Previous to describing any of these places in particular, I would observe that commencing from Allahabad and proceeding down stream towards Revelgunge, the traveller would observe that all those portions of the bed of the river, which are found shallow and difficult to navigate, the main banks will be found of a somewhat looser material than is generally the case elsewhere, and the breadth of the river greater than usual, owing to the banks having been worn away by the violence of the stream during the annual floods.

Nature of the soil of the banks where these occur.

4th. It will also be observed, that the main banks are of a much finer nature from Allahabad to Buxar, (with here and there an exception) than below that place, owing to the country being harder and abounding in kunker, whereas below Buxar there is none anywhere visible, as far as Revelgunge, although fortunately here and there a good deal of mud will be observed, but it nowhere has that consistency and adhesiveness, which characterises the English blue and other coloured clays.

Nature of the soil of the main banks more consistent between Allahabad and Bulleeah, with occasional exceptions than further down.

5th. Hence during the rainy season, at these places, there is not only more alluvial matter brought into the river from Inland by the tributary streams, but the main banks themselves easily give way to the fierceness of the current, thus causing great devastation to the banks, and extra width in the river's bed; and as the water generally runs swifter at one side of the river than the other, the other side will be comparatively still, or, where favoured by the configuration of the sides, there may even be an eddy; at any rate at the slack water side of the river the deposits will take place, and in the after mutations in the river, this sand or mud, or whatever the deposited matter may be, will be washed here and there, causing delay to navigation by stopping up the channels, and it will be at once perceived, that

Abundance of loose soil drifted with the river in the annual inundations, and carried down by the current, or kept stationary by eddies according to the river caprices.

it is from Inland that all these deposits are brought, and not from the mountains, although where it comes from may be immaterial, except for the consideration that if there were no floods, the river would cease to receive these Inland supplies of mud or sand, and would in the course of a year or two become navigable.*

Effects of width of stream, with sandy soil in either margin and in the bed of the river.

6th. When the distance between the river's banks is great, as at Bulleeah, Revelgunge, &c., and from which the waterway is consequently larger than in other places of ordinary breadth, and which supposing the depth to be the same, the water must run slower at such a place than at a narrower portion of the river, but as the water is generally observed to run with greater rapidity in some portion of the lateral section than any other part, and as this current is very swift at Bulleeah, Revelgunge, &c., where the river is broad, it must follow, in order that the water of rivers may fulfil the rule of the *same quantity* of water runs through *equal spaces* in *equal times*, that the other portion of the lateral section must run proportionately slower than it would do in a narrower portion of the river. Hence deposits of sand, &c., naturally take place in localities, similar to Bulleeah, whereas in the narrow waters the stream is necessarily too swift to allow any great deposits to take place. So that in these broad portions of the river, these deposits of sand become shifted here and there, as the winds and capricious energy of the river may direct, so that when the river falls, the water will be most likely running in between shoals and sands instead of the main banks, and this sand will be washed away into the stream to be spread over the bottom or form new shoals and sandy churs, causing great sinuosities in the channel, which though there should be a sufficient depth of water in it for the largest craft that ply on the river, yet from the channel being tortuous, steering may be difficult, besides the eddies and whirlpools which are always numerous while a new channel is forming, the water scooping out the sand from the bottom of the river, leaving a concave circular hole in the bottom; in this way, doubtless, vast quantities of sand are stirred up and carried down stream.

Effects of eddies and whirlpools.

7th. That such will be the effect may be easily deduced from making the water run round, similar to the eddies, by revolving a stick in the water, and it will be immediately perceived, that there will be a circular cavity, of no small size, formed in the sand. The Native boatmen on observing these eddies, observe that "*darya khadta hai*" and that it will soon be deep.

Bulleeah Flats. Rapidity of the stream by reason of general shallowness; effects of the winds on the river channel through numerous shoals; comparison of the River Ganges, with other rivers less subjected to variations of increase and decrease of water.

8th. There is hardly any utility in describing such places of delay as the Bulleeah Flats, &c., as their general characteristics must be familiar to all travellers on the Ganges (which probably includes nearly all the European inhabitants of the North-Western Provinces and Bengal,) as they are all similar, if we except the nature of the main banks, and the speed of the water, both of which somewhat affect the character of the place, for if the water is swift the shoals of sand, lying in the bed of the river will be liable to continual change with every shift in the wind or increase of the water. The winds which generally prevail are from the East or West, and by a glance at a map of India it will be perceived that the River Ganges between the mouths of the large Tributary Rivers, Coosee and Jumna runs from West to East; and consequently between Allahabad and Paturghatta, the general line of the river will coincide with either the direction of the Easterly or Westerly winds. The former of which decreases the speed of the current, and consequently it must, in order that it may escape, either deepen or rise, hence the beneficial effect which an Easterly wind has on the channels,

* What the people say is doubtless true, that in the seasons in which the rains have been scanty, the channel of the river is more certain and free from obstructions.

whilst the latter increases the speed, thus causing the water to drain off quicker, and also to have greater force in washing in and altering the position of the masses of sand in its way. If the water did not move at all, and the bed of the river was gravel or mud, there would be no alteration or motion at its bottom, but wherever the bottom consisted of mere sand, even though there was no stream or motion in the water itself, still a strong wind would move the sand at its bottom, unless where the water happened to be deep: but if it was either gravel or mud, dredging machines would soon deepen a portion at the expense of the remainder of the transverse section of the bed. In most rivers of Europe or other parts of the world, the courses of rivers lie in a meandering line, meeting with mountains and valleys, as well as an extensive level of low land or even a table land, but when it reaches the low level land as in Holland, or any similar country, the tide assists what might otherwise perhaps be an insufficient depth of water. Another thing worthy of consideration is, that the soil of the great levels of most countries is dissimilar to that which borders the Ganges, being heavy loam perhaps mixed with clay; consequently, though sufficiently adhesive in itself to prevent great encroachments in the main banks, yet sufficiently weak to allow the river to deepen itself considerably. Here we have sandy soil for the Ganges to take its meandering way in, which easily gives way to the fury of the water in the rains. Another advantage which the rivers of other countries have over us is, that the rains fall at various periods in the year, thus causing an average depth of water in the beds of the rivers; here we have it all in a lump and then it may sink as low as it can.

Comparison of the Mississipi with the Ganges.

9th. The great River Mississipi is in many points similar to the Ganges, except that water falls from the clouds for the greater portion of the year than it does here; still, near its mouth, there are no Sand Heads, but the bars are nearly entirely composed of mud, and the tide has effect to an enormous distance up. So that, though the Ganges may pour a vast quantity of water into the sea while flooded in the rainy season, yet what does it amount to during three quarters of the year, and especially in the months of March and April? I have never tried the amount, as it is a very delicate experiment, and I had no instruments whatsoever; still from general observation, and consideration that many parts of the bed which are covered with water, which has no motion, should be subtracted and the scantling of the moving water taken, it would be found to be far, far, under the popular notion of its amount. So that my idea of the mighty Ganges is decidedly much diminished, as it has no right to be considered a great river, except in the rainy season, say from 1st July to the end of September, which is three months,—and nine months it is a small river choked with sand and almost unfit for navigation.

Explanation of the law of rivers, which regulates the speed according to depth or shallowness.

10th. As previously observed, instead of mud or gravel, the bed of the river is nearly all sand, except here and there where kunkur or solid rock exists; and the water runs very swiftly in some portions of the river, while at others, where the water is deep, it hardly moves at all. This last fact is easily explainable by just considering that as the same amount of water must move through equal spaces in equal times, and whereas in the one case the water-way is larger, deep, and in the other extremely shallow, it follows that in the latter case it must move much quicker, in order to fulfil the above conditions; and as the channels at Revelgunge, Bulleeah Flats, Sirsa, &c. are choked with sand, and therefore, in other words, very shallow, the water must run swifter in those localities than where the contrary is the case, that is where the water is deep. Thus having given an explanation which, in my opinion, is the true one, and at any rate, it is one that sufficiently answers all the conditions of the case, it will answer as a theory for the Ganges as well as many similar theories of analytical chemistry, which though, perhaps, not quite correct, answer all the conditions. This explanation is perhaps too simple to be credited by many people who have thrown aside common sense for abstruse

geological and other unnecessary matters. I will now state a few of the peculiarities of the Bulleeah Flats and the other somewhat similar places.

Bulleeah Flats,—extent and character.

11th. The whole length of the Bulleeah Flats may, by the river course, be 20 miles *(i. e.)* from Kurrowlee on the West to Dubowlee on the East, both of which are villages situated on the right bank of the Ganges (*vide* Sketch No. 1,) which gives the general run of the river at the *Bulleah ka panee.* This place is notorious among both Europeans and natives, on account of the unusual length to which it extends, and quick or loose sand of which its bottom is composed. The main banks are generally soil and sand with rarely a portion of mud, but no kunkur; the breadth of the river's bed is, consequently, considerable, and choked with this quicksand, which the force of the water is constantly changing from one place to another, until about the end of January or the middle of February, when it settles itself into its natural bed or channel and is then somewhat manageable, not but what a strong wind from the West will move the shoals about a little, or a Steamer badly piloted, will fill up all the channels below where she grounds.

Little affected by the influx of the Surjoo.

12th. The Surjoo can have no detrimental effect on the channels, beyond the mere throwing up of a chur, and attached to it, what the natives call a *Kanchi* or long spit of sand under water, for some distance after the rivers have apparently mixed their waters.

Character of the Surjoo.

13th. It will always be observed that where a small river runs into a large one, that their waters will continue separate for some time, the stream of the smaller river runing down the side of the main stream; this is easily perceived when one of the streams has a muddy stream and the other a comparatively clear one, another fact generally observable is, that the mouth of the tributary will be somewhat shoaled up, and inside the mouth, a little distance, the water will be very deep. Both these facts will be easily perceived on inspecting the Surjoo, which, in the rains, is said to be connected with that very rapid river, the Gogra or Ghāgra. Except in the rainy season, and immediately after it, the River Surjoo is very quiescent compared to the Ganges, except just at its mouth, where, from its being shoaled, the stream increases its speed a little.

Revelgunge resembles Bulleeah, but to a much less extent.

14th. It may be perceived, therefore, from my description that the Bulleeah Flats are about 20 miles in length, of extra breadth, and choked with loose sand, through which the water rushes in eddies, whirlpools, &c. Revelgunge is only about 5 miles in length, viz., from the village of Tullootollah to the town of Revelgunge (*vide* Sketch No. 2.) The river's bed is very broad, but the water does not spread quite so much as at Bulleeah; its characteristics are the same as those of the Bulleeah Flats, except that its extent is just $\frac{1}{4}$ of the former, which is in itself a very great difference. The sand is loose and shifts about considerably with every change of wind, but it is more manageable than the Bulleeah sands.

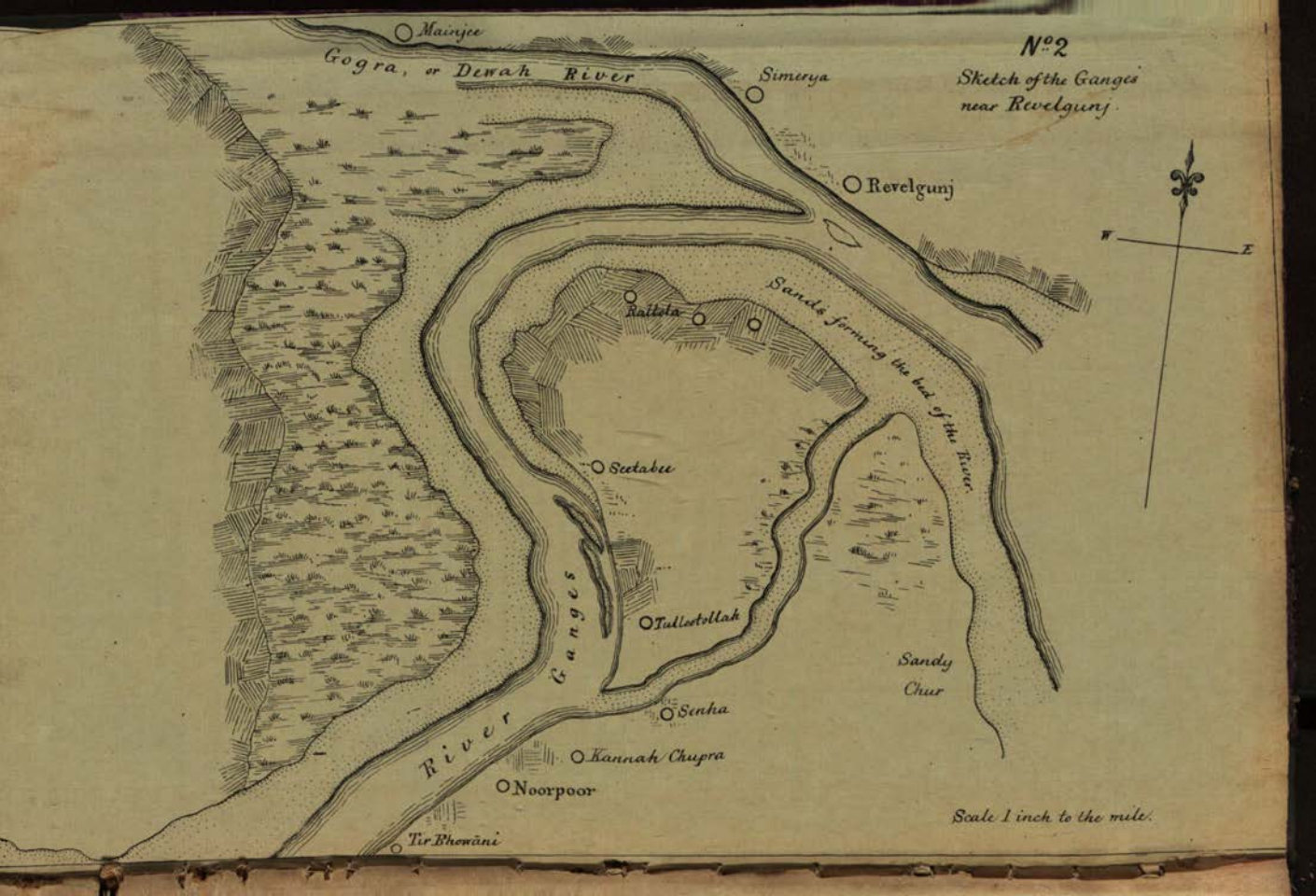
And is far more manageable.

15th. One Overseer of moderate intelligence, and who had some knowledge of the practical operations, would be quite sufficient for this place, provided he was occasionally visited by the Engineer.

Bhuttowlee less in extent than Bulleeah;—the sand of a firmer consistency,

16th. Bhuttowlee very much resembles the upper part of the Bulleeah Flats, that is, that portion which comprised Overseer Bramley's beat, viz., from Kaisoolpore to Buxar; but it is not so extensive, being in length from Larroo to Chathah, a distance of 4 miles; but I am given to understand, that it varies in length

No 1
Sketch of the
BULLOOA FLATS
March 1838


Mainjee
Gogra, or Dewah River
Simerya
Revelgunj
Raitola
Sands forming the bed of the River
Seetabu
Tullestollah
River Ganges
Senha
Kannah Chupra
Noorpoor
Tir Bhowāni
Sandy Chur
W
E
No 2
Sketch of the Ganges near Revelgunj
Scale 1 inch to the mile

every year. The sand is firmer here than down below, but this is probably owing to the sand being less shifted about than it is at Bulleeah.

The Sirsa Flats most easily manageable, from portions of kunkur in the bed of the river.

17th. Finally, the river at Sirsa is much narrower and more rapid than either at Bhutowlee or Revelgunge, and of even many portions of the Bulleeah Flats, and is the easiest managed of them all, from the quantity of kunkur here and there in the bed, which would be fixed points from which to work on and improve the channel; but it would be of little use annually improving the upper portions of the river, if the lower parts are not simultaneously improved, to enable the Steamers to approach the mended channels up above.

Nature of other obstructions, sunken trees and boats, rocks and kunkur beds.

18th. It appears evident then, that the great hindrance to navigation consists in the channels being unnavigable from the want of a sufficient depth of water, which is caused by a superabundance of sand choking them up; from this there is comparatively little danger, but great delay. The other difficulties are sunken trees, and boats or kunkur and solid rock, navigation is but little delayed by these, but there is great danger from them. The Steamers manage to avoid these dangers, but the apathetic boatmen, of native craft, too often meet with great disasters from them, some of these should undoubtedly be removed, by a similar process to that employed in clearing the River Jumna; and the least expensive and also the quickest way would be to employ a few Sappers and Miners, or the new body called Pioneers, but who do exactly the same work, as they are supposed to be already acquainted with the use of their tools; but as there would be an objection to employing them even for a short time under any one but an *Engineer Officer*, much less to a non-combatant, like a Civil Engineer, it would doubtless be of no avail asking for such aid, unless an Engineer Officer was requested to accompany them.

Kunkur beds in mid-channel.

19th. The most objectionable of the kunkur beds, are those that are separate from either bank, and the first place met with of this nature is at Baireah, about 5 miles S.S. W. of Ghazeepore, where 4 or 5 kunkur rocks are to be found, though often covered with sands, but nearly in the middle of the river's bed.

The same subject continued.

20th. The next is at Chochukpore, close to the left bank of the river, which is exceedingly dangerous, this might be sufficiently removed to prevent the loss of any native craft, at a trifling expense compared to the service to be rendered by it. The village of Chochukpore is about half way by land between Ghazeepore and Saidpore.

The same subject continued.

21st. About ¼ mile below Deochundpoor, and on the left bank of the river, there are 3 large kunkur rocks, somewhat separate from the main bank, which come into my list of those which ought to be removed. At Chandroutee there is a very dangerous mass of kunkur, with a large stone dedicated to Māhādeo, on it, at the S. W., and which is much higher than the remainder; the removal of this rock from the bed of the river though very desirable, would yet, doubtless, be very unpalatable to the inhabitants of Chandroutee, who are said to make a great profit from the rock wrecks, and all the saved property coming under the title and denomination of zemindareā hukk, goes to the landlord or landlords of the place and his assistants in the works, the god, would of course take a jump on shore directly operations commenced on the kunkur.

22nd. There is also a very dangerous mass of kunkur under water nearly opposite mouzah Sarrainah, a village situated on the right bank of the river about 5 miles above Chunar.

The same continued.

23rd. There are also numerous masses of kunkur in the neighbourhood of Chunar, especially near Turnbullgunge and Sultanpore, but there are also four masses of flat sandstone rock opposite to Turnbullgunge, which it would be just as well to leave alone, provided a staff were erected on the outermost edge to warn boats off, this last year these rocks were uncovered about 18 inches. At Bhogāon, Bindachun and just below Sirsa are kunkur ledges, which it would be well to remove. Besides these, there are numerous kunkur spits between Allahabad and Buxar, which as they strengthen the main banks, might probably be allowed to stay where they at present are, but all those rocks and kunkur, which are detached from the side, should decidedly be taken up.

The same, notice of kunkur beds united with the river banks. Their utility.

24th. The next point is the removal of sunken trees or boats which may be in dangerous contiguity to the channel. The best way to manage the boat is to put a charge of *blasting powder* in it and blow it to pieces, by which the detached bits of wood might be easily removed by divers or boatmen, and sold as firewood in order to partially cover the expenses of the operation.

Sunken trees and boats. The latter are best disposed of by gunpowder.

25th. Trees may be lifted by means of a couple of large boats, which should be laden with rubbish down to the water's edge, and one on each side of the tree should be securely fastened, when by throwing the rubbish out, the boats would rise and lift one end of the tree; the details being simple, need not be entered into here.

Process for removal of sunken trees.

26th. Whether the sand be firm or loose, the same method of improvement answers, viz.: the use of the *Bandahl;* supposing the Bandahl to be laid down, the most effective way of doing it, would be as represented in Sketch No. 3, although for economy's sake one ½, as A. B. is generally left out, and in its place a few boats anchored in a similar line, or else nothing at all substituted in its place. The Bandahl which we have generally used on the Ganges experimental works this last year, was generally constructed as follows: viz., strong first class bamboos were first put down in the desired direction, as far as they could be got into the sand by the system of wabbling, and then they were hammered in as far as they could be got, and about two feet apart from each other, unless where the water was very shallow, where circumstances permitted their being placed wider apart, as the strength of the Bandahl was increased or diminished in proportion to the degree of strain it was liable too when all the bamboos were sunk to the required depth; the next operation would of course be to affix ties or strong horizontal bamboos, each overlapping the other about five feet, and tied to each vertical bamboo by country twine, after this at intervals of six feet or so, sloping struts, consisting of long and stiff bamboos, are imbedded in the sand about four feet, and then bent down and tied to the horizontal, to prevent the force of the current outside from pushing the Bandahl bodily over; after finishing this, weights should be applied, say heavy stones fastened by strings at intervals along the line of Bandahl to the tie beam, so that as the sand eats away, the Bandahl may be forced to settle down *en masse.*

Description and uses of the Bandahl.

27th. The final operation consists in putting down the jhâmps on that side of the stakes on which the stream runs, these jhâmps should be put in so, that they may overlap each other about eight inches, commencing down stream, they are

The subject continued.

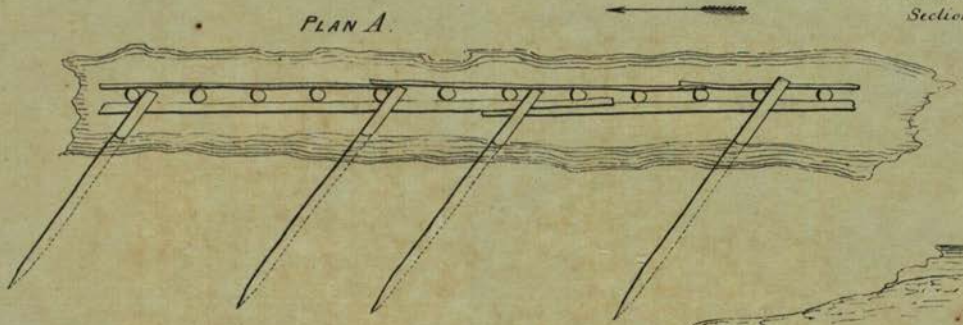
SKETCH No. 3.

Illustrating the mode, position & direction in which Bandāls *should be placed, in order to shoal and shut up side Channels &c. so as to deepen the Main Channel.*

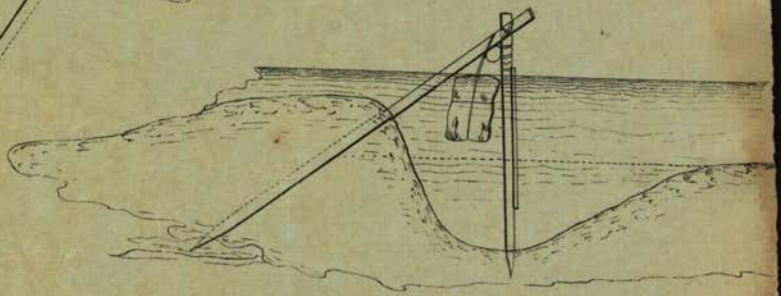
SKETCH No4.

Shewing Plan A. Elevation B. Section C. } of a Bandâl C. shewing the effect on the Sand after the Jhamps have been down a couple of hours.

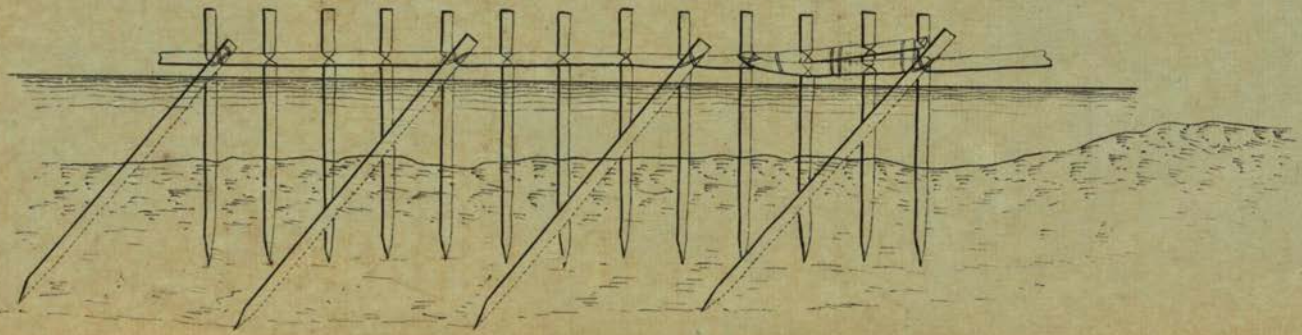
PLAN A.



TRANSVERSE SECTION C.



SIDE SECTION OR ELEVATION B.



then with a little country twine fastened to the bamboos, and now as every portion is firmly fixed to each other, the whole must give way and be lost before a portion only can be so.

The same.

28th. The mats should be of the species called *mashat* or *nal mats*, and not more than three in a *jhâmp*, which will then be about 12 feet long and 3 feet deep; unless the water should be very deep, when the mats should be fixed to the framework with their length across instead of along the frame. All the mats should be pressed, down with their edge in the sand. The effect of this Bandahl on the river will be easily perceived. Sketch No. 4 comprises a plan, elevation, and cross section of the Bandahl supposing it to have been made in a couple of hours. The difficulty is to keep the thing standing long enough as the sand eats away from underneath the bamboo piles and settles just behind as shewn in the sketch, if the Bandahl is deeper than three feet in the water it will hardly ever stand more than half an hour, provided the stream should be at all strong, but in 2 or 2½ feet it can be made to stand a long time by driving down the stakes with a heavy mallet as the sand eats away.

Description of operations. Inefficiency of the pilots, and their jealousy of the Overseers.

29th. The routine of operations during this the first season, when all the subordinate establishment knew nothing but their drill, was of course somewhat adapted to their case, and consisted, in the beginning, as follows, viz., each Overseer having had his beat or the quantity of water he was to be Overseer of assigned him, was next ordered to make himself acquainted with his channel, and then to put marks down on the edge of it for the guidance of himself or any of the river craft passing up or down. To report to the Engineer the nature of the channels, so that they might be deepened whenever necessary, and also provided the steamers would stop for him, to board and pilot any of them through his beat, and to assist all native craft as far as in his power lay, provided it did not interfere with any other more important and particular duty. In the beginning of the cold weather and up to the end of February, the pilots don't know their channels, as they are constantly changing, and they don't know the feeling of having any pride in their work like a European, all they care about is to get their pay, and if an Overseer went on board and found the pilot was taking them wrong and explained the matter to the Captain of the vessel, he was but little attended to, and so it only had the effect of making the native pilots dislike us without doing much good; consequently the Overseers, if they could escape going on board, did so, unless I was in the neighbourhood, when of course, they were obliged to be on the alert. But the Overseer had no other object than that of getting the vessel quickly through his beat, the channel of which he was thoroughly acquainted with, while on the contrary the pilot went by the native craft as he saw them moving ahead of him, and consequently would not be certain whether the steamers would ground or not, especially as there are many sharp turns in the channels at Bulleeah, the consequence was, that few steamers escaped sticking, even though the channel might have been sufficiently deep; this was of course very annoying to me especially as directly any steamer grounded, the channels below must become blocked up before she is off again, so that the steamers in reality spoil the channels more than the weather or any thing else. Hence, it is absolutely necessary that the pilot system should be altered and be entirely in the hands of Government, to whom the steamers belonging to private Companies should pay a stipulated sum, and the people on the river should be allowed to have some control over them, to see that they did their duty and measured their channels, and also keep them at some work for the benefit of the river navigation, instead of allowing them to spend their high pay and presents in the native spirit shops, where they are always to be found, either drunk or in a squabble, instead of minding their proper business.

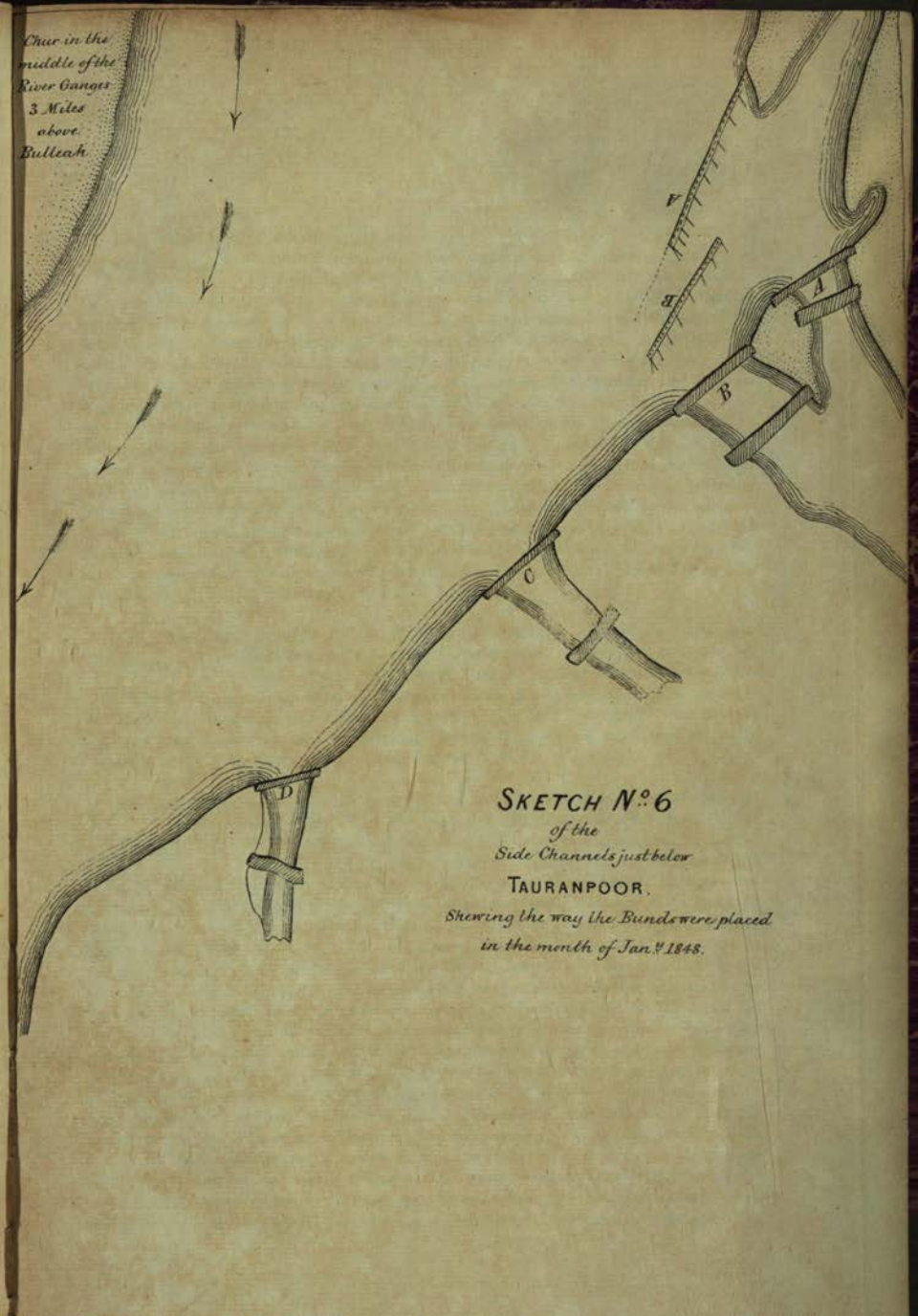
30th. When the water had sunk sufficiently, the works commenced, and consisted generally in stopping up all side channels to divert the water into the main channel, and also the erection of Bandahls wherever required and various other means were resorted to, to deepen the channel. The plan was to shoal up the superfluous breadth of the river by means of Bandahls, these always had a good effect, but were too weak for the rush of water, considering the loose sand in which they were fixed, which was soon washed away from under the bamboo stakes when the whole thing fell down; this would not have been the case near so soon, had the stakes been further down in the sand, but we could not get them in further; no doubt, if we had had some pieces of round timber, termed Bālaposts? from 4 inches to 8 inches diameter with a small pile driver on an Agra salt boat covered with a firm platform, and put down a few of these posts at intervals along the line about 6 feet into the sand, the Bandahl might have stood. I have heard something of this sort, is adopted in the improvement of the Nuddeah Rivers, and surely the Ganges is of sufficient importance to warrant a similar, if not, a much greater outlay, provided it is necessary, and that it is so, is my *decided opinion;* because, if we could once get over the difficulty of our slight Bandahls giving way so quickly, and the river Overseers had learnt sufficient of their practical duty, it would only remain for the Engineer to point and lay out the lines of the necessary works with simple instructions for the guidance of the subordinates, and then be off to improve another portion of the river under his charge; this was far from being the case this last season, as no one knew any thing, and even the most simple operations, I had to see done or to do myself. At last one or two of the Overseers did learn enough to be of considerable use to me, and the best of them all was, finally, Overseer J. Bromley, of the Artillery Invalids, at Chunar. During the last season there were many difficulties to be overcome, which were not conquered, the delay in procuring the necessary materials for the clearing works, during which many steamers were delayed, as the demand being urgent, the materials rose somewhat in the market, though, through the assistance of the Tehseeldars of Bulleeah, &c., I managed to get them cheaper than any one else, but materials ought to be collected before the season of the works commence, so that there may be no delay. The materials used at Bulleeah are of no further utility, or next to none, as they were used so often, being taken up from one place to be put down in a worse, to save the outlay of money, hence our works at Bulleeah were far from being so effectual as they otherwise might have been, as if we had let the Bandahl remain in its old place, it would have prevented the river getting bad again at that spot.

Operations continued.—Difficulties of retaining Bandahls in position without great expense on their construction.

31st. I now proceed to describe briefly a few of the works which were executed at Bulleeah, &c., as examples of what was done during the last season, and as foreshewing what might be the effect, provided the work and establishment had been more efficient and the experience of the last season brought to bear on the work of improvement for future years. During the months of November, December and part of January (owing to the channels being in a very unsettled state) no other operations than merely learning and marking off the channel in its continual changes so as to guide the steamers and native boats, were carried on. The current, however, was so strong, that the painted bamboo stakes used as marks would not stand, still this was partially remedied by putting the stake into the sand at an angle of 45° sloping up stream, when the force of the water partly helped to push it into the sand deeper than it was before, but from the wabbling motion which it had, the sand about its bottom was disturbed and washed away, and the mark of course soon followed; but this was only in the strongest water, most of the marks being carried away by native boats carelessly running them down. Under these circumstances there were various substitutes for the bamboo marks, many of them very good ones, which it is not necessary to particularise here, as many will occur to the mind with little thought, being a simple subject, though of much utility.

Operations at Bulleeah.

No. 5
Sketch of the Mud Bank and the Means of overcoming it.
Very Shallow Channel
Long Sandy Chur
From this up to Buxar, (2½ miles,) the Channel is broad and deep, probably from the mud and Sand at this place acting as a Bund.
Anchored Boats
Mud Bank
Chur
Stinken Stone Boat
Chur
Chur
Chur
The River is very shallow here being choked with Sand and Shoals.
Fine deep Channel
Mud Bank below Buxar
Main Bank is sloping and firm on both sides of the River.
Mud
Open in the Rains
Mujerja



SKETCH No. 6

of the

Side Channels just below

TAURANPOOR.

Shewing the way the Bunds were placed in the month of Jan.y 1848.

32nd. From January up to the end of May, there were various numerous works carried on for the improvement of the main channel of the river, many of which experiments were attended with complete success, keeping the channels good as long as the improving cause was in existence at the place, that is if the river had shoaled so much at any place as to render it imperative on us to try and improve it, and that we did, so completely, with a Bandahl, a day or two after the Bandahl had been taken up to be put down in another bad place (this was for economy's sake) the channel at the old place might get as bad as ever. The first work of any magnitude that was undertaken was the shutting up of all the side channels in the great Bulleeah Chur, just below the village of Sauranpoor, through which a considerable body of water made its escape to the detriment of the main channel. These works (*vide* Sketch No. 6,) were unsuccessful in the first attempt, but were finally all of them shut up, though with considerable difficulty, to the manifest improvement of the main channel in the neighbourhood. In one or two instances the bunds gave way, but were fastened up again directly, experience has taught me the readiest method of doing this, which, is first of all to shoal up the mouth of the side channel just outside the mouth, on the top of which shoal a temporary bund should be made by pitching sand out, if this small bund should be made a foot broad at the top, it will be quite sufficient. This bund won't last, as the waves from a passing steamer or a strong breeze will at once demolish it, hence calm weather is the only time in which this kind of work should be executed.

The subject continued.

33rd. After this temporary bund shall have prevented further ingress of the stream, a *strong bund* must be constructed at any convenient place, at from about 30 to 50 yards inside of the mouth of the side channel. In this manner A B C and D in Sketch No. 6, were finally overcome. The Bandahls A and B were put in the position marked in the Sketch, to shoal the water behind them, and divert the stream away from the side channels whilst they were being fastened up, and were taken up immediately after the channels were effectually stopped, to be used in the improvement of other localities.

The subject continued.

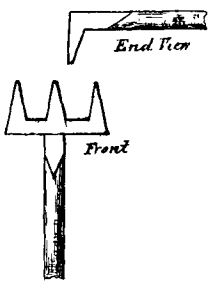
34th. Sketch No. 5 represents the operations connected with the removal of the *notorious mud bank* of Mujeria, about two and a half miles to the east of Buxar. It lies in Overseer Bromley's beat, and I had directed him, previous to its final removal, to try the effect of taking out a quantity of mud in *dingies*, at the narrowest and deepest portion, and accordingly 180 boat loads were carried away off the bank; this had a very good effect for about five days afterwards, when it all filled in again as bad as ever; the only advantage derived from this removal of the mud, was the allowing an immense number of native boats which had been stopped by it and were *lagowed* just below it to pass over, and a couple of Government steamers; but on the 5th day the *Patna* came up, and I took her over myself and though the Captain wanted to go gently at it, I persuaded him that it was much farther bad, and that he need not stop the engines there, the result was that she went bang at it, and the Captain did not know where the mud was till we were over it about 100 yards; but the engineer was greatly astonished, as from merely getting over it by the momentum of the vessel, and not from floating over it as there was only 3 feet at the deepest part, which was just where they were taken: the result was that she slid over it with her paddle-wheels considerably less in the water than usual and they went spinning round with great rapidity from meeting with but little resistance, hence the engineer's astonishment, as he did not know till afterwards, what had given rise to such increased velocity of the piston rod. After this, from the falling of the water and one thing and another, the place had become so bad that the Bandahl, &c., marked on Sketch No. 5, was put down and acted with great force, as the bottom of the *jhâmps* made of very thick *jhow* were pressed into the mud, which did not wash away from underneath, as is the case with the sand; consequently, all the water had to run round the end of the

Operations on the mud banks near Buxar.

Bandahl at A. Fortunately a storm from the West commenced blowing just when the Bandahl was finished, which greatly increased the rapidity of the stream, and the result was that the effects of the wind, the Bandahl, and the coolies and boatmen with shovels and rakes stirred up the mud all conjointly, that it was cut through 24 hours after the work was commenced, and instead of 2½ feet in the centre of the channel there was 7 feet in the centre, and 5 feet at the sides of a channel 130 feet in breadth, thus affording a clear proof of the effect of a well constructed Bandahl put down with a little judgment as to direction and length, &c.

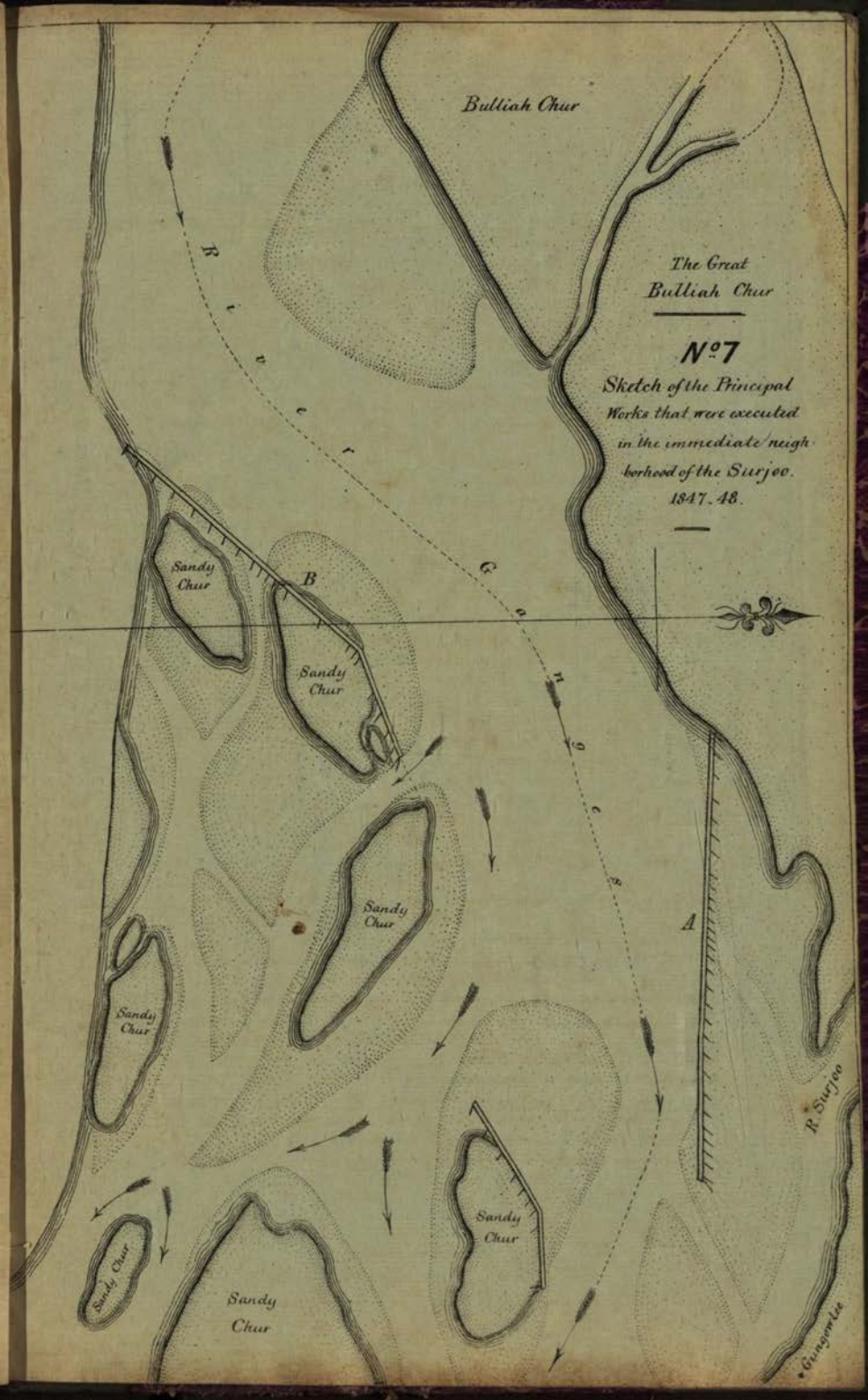
The subject continued.

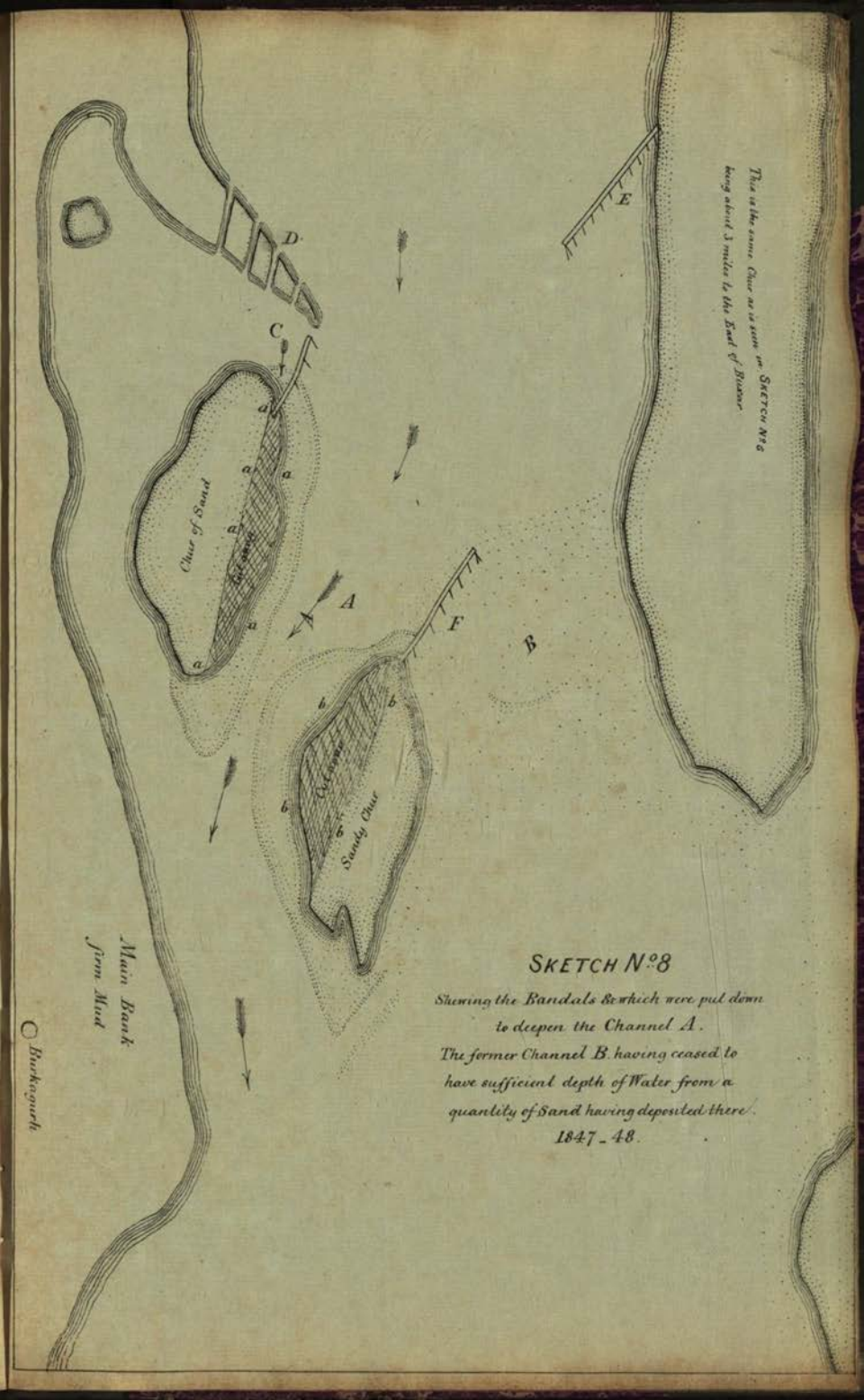
35th. The next operation was to cut off the corner of mud at C, round which the channel runs with a stream of great speed; this was done by a number of coolies in two days, part of the mud being put down in the shape of a shoulder at *b*, to give the current a throw outwards, and as a means of filling up the corner effectually, so as to prevent any more water running in the small stream, which runs near the village of Mujeria, was fastened up with great difficulty at *b*, and opened again at B; thus causing the stream to run into the main river at right angles, the deposits from the muddy water of which settled in the eddy caused by the new direction of the stream, which completely filled up the recess *x*—by this means the channel became straight and regular, whereas previously it caused a great deal of trouble to the large steamers as the *McLeod*, *Benares*, the *Patna*, &c. Soon after the operations at the mud bank, it was found that the channel had suddenly changed from B to A, (*vide* Sketch No. 8,) probably induced by the new channel being cut in the mud bank; the operations will easily be perceived by looking at Sketch No. 8, viz., a Bandahl was put down at E, another at C, and a third at F. The mud at D, was cut through here and there so as to allow the water to run with force on the Bandahl C, which cut away the dark portion of the large chur *a a a a a*. The Bandahl at E threw the water off on to Bandahl F which caused that portion of the chur which is dark coloured and marked *b b b b* to be cut away, and then the channel having obtained sufficient lateral dimensions to allow a large body of water to enter, the coolies were put into the water with rakes of the shape shewn in the margin with long handles. When the operations commenced there was a channel at neither A nor B, and when we left off there was 8½ feet down through A, as indicated by the arrows, and the channel remained there ever afterwards.



Operations at Bulleeah, under direction of Captain Smyth, Engineers.

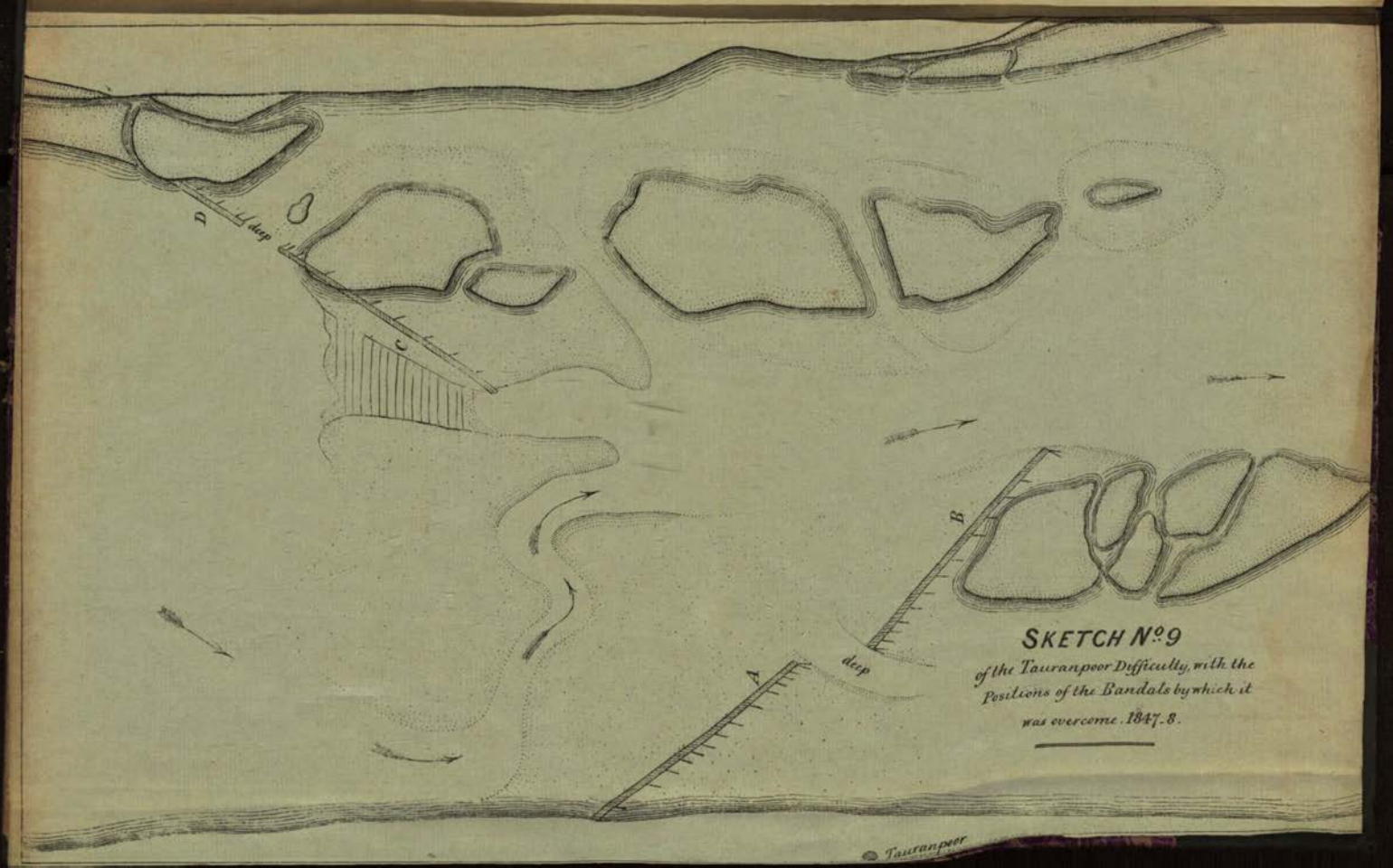
36th. Sketch No. 7 represents the River Ganges close to the Surjoo, where the Bandahl A was put down by Captain Smyth's Baboo, who was left by that officer under me for a short time. I then made him put down the Bandahl at B, from both of which acting simultaneously, the river never got bad afterwards at that place, though the sands cleared out by means of them settled down by Gungowlee, and completely blocked up the channel there, which caused fresh works to be undertaken for its clearance, but during these intervals from the want of materials in store ready for work and an insufficiency of working hands, &c., many steamers were delayed some time from want of a channel, and at others from the ignorance of the pilot, when the channel was good. The sand cleared out by the works shewn in Sketch No. 9, settled a little to the west of the narrow portion of the river comprising the *upper portion* of Sketch No. 7, which also was cleared out after my leaving Bulleeah Flats by Overseer Bromley on the same system as he had been taught while acting under me. On observing Sketch No. 9, it will be observed that there are no less than 4 Bandahls down; this was caused by the great extent of shoal water requiring to be improved, and of course, putting all these down and the necessary con-


Bulliah Chur
The Great
Bulliah Chur
No 7
Sketch of the Principal
Works that were executed
in the immediate neigh
borhood of the Surjoo.
1847. 48.
Sandy
Chur
B
Sandy
Chur
Sandy
Chur
A
Sandy
Chur
Sandy
Chur
Sandy
Chur
Sandy
Chur
Sandy
Chur
R. Surjoo
Gungamdee



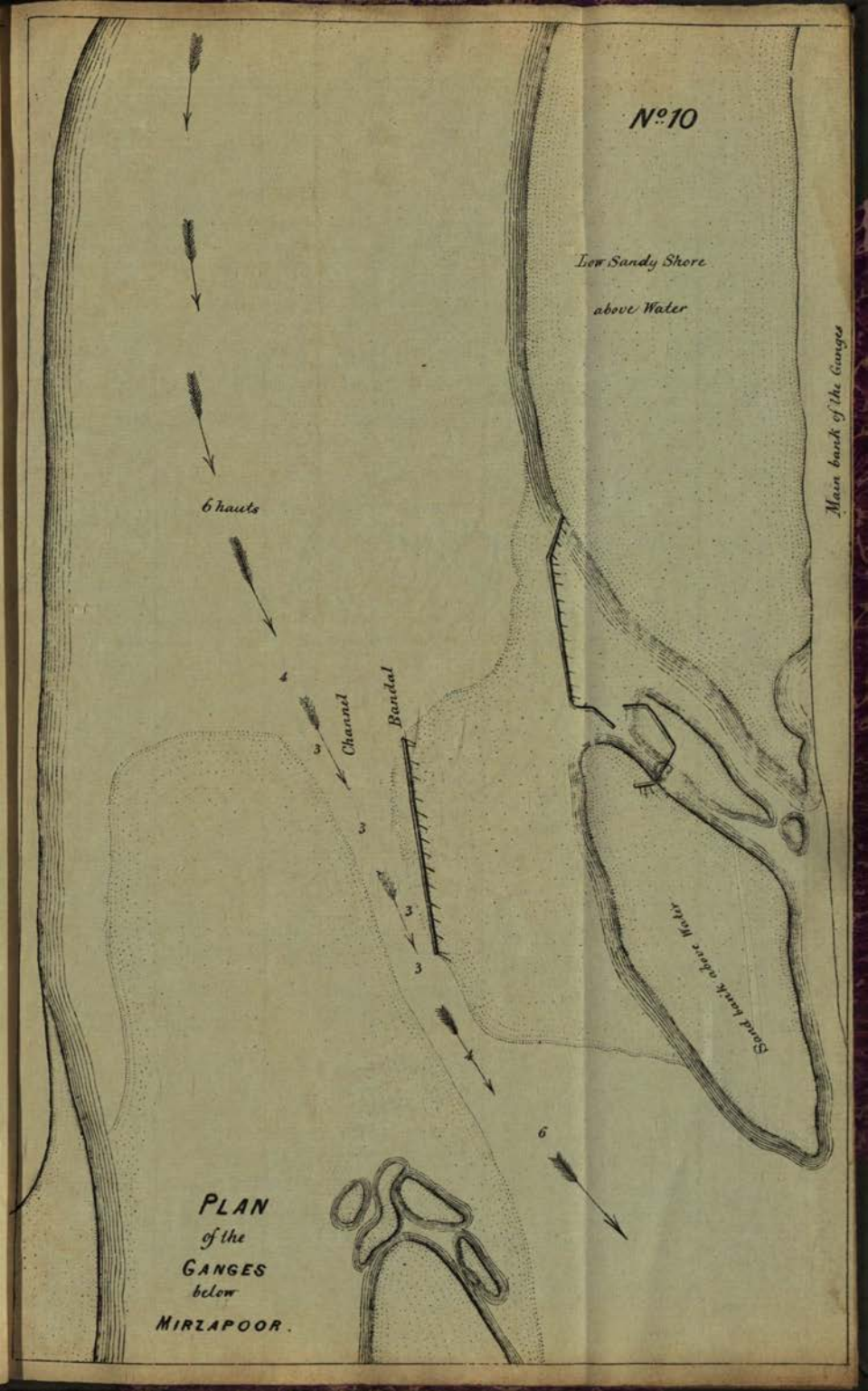
SKETCH N°8

Shewing the Bandals & which were put down to deepen the Channel *A*.
The former Channel *B* having ceased to have sufficient depth of Water from a quantity of Sand having deposited there.
1847_48.



SKETCH No. 9

of the Tauranpoor Difficulty, with the Positions of the Bandals by which it was overcome. 1847.8.


No 10
Low Sandy Shore
above Water
Main bank of the Ganges
6 hauts
4
3
Channel
Bandal
3
3
3
Sand bank above Moh
6
PLAN
of the
GANGES
below
MIRZAPOOR.

tingent operations occupied a long time with our small establishment, but they require little or no explanation, as the previous matter will have illustrated this kind of work and the Sketch itself explains the direction and length of the various Bandahls with the relative positions of the shoals, &c., it is sketched in quickly to a scale of a mile to the foot as near as possible, so that it is merely necessary to say that the Bandahl D was put in first, and the *Sir F. Currie* Steamer nearly upset it, after which the one at A was put down, subsequent to which C and then B were finished; this, however, required all our means, so that the bamboos, mats, &c., from every other place were taken up to finish this. The reason why B was not a continuation, was that the water was too deep between to allow of it, but finally, that side channel, though a good third of the whole breadth of the river, was so much shoaled up by these Bandahls, that very little water was running through when I left Bulleeah, the channel was completely improved by these Bandahls, but the *Mirzapoor* and the *General McLeod* spoilt it, through being taken out of the channel by the Pilot.

Misconduct of Pilots and mischief caused by large Steamers.

37th. There ought to be some heavy penalty inflicted on the Pilots of Steamers, who take vessels out of the proper channel when there is a good one for them; finally, (as the above examples may perhaps suffice for this report,) I would observe that many people have informed me that the river has been much lower this last year than ever it was before; whether this be correct or not, I am unable to say, but if it is correct, that the river has sunk one cubit lower this last year than it ever did previously, without enquiring into the causes, suffice it to conclude by saying that considering the large Steamers which have but lately commenced running and which have spoilt the channels more than all the other Steamers put together, have been on the whole lucky in not having met with more detention during their trips on the River Ganges.

I have, &c.,

(Signed) W. LLOYD,

Supdt. River Ganges Works.

BENARES, *June*, 1848.

Instructions issued by E. A. READE, ESQUIRE, *Commissioner of Benares, to* MR. H. ALONE, *River Inspector, for ascertaining with accuracy the traffic of boats on the River Ganges, within the range of the Benares Division.*

1st. The object of your appointment is to ascertain, with all possible accuracy, the traffic of boats on the River Ganges, within the range of the Benares Division.

2nd. Ghazeepoor has been selected as the best spot to carry on the observations, and application has been made to the Rajah of Benares, to allow you to occupy an apartment in his upper-roomed house, now vacant at that station.

3rd. Your duty will be to ascertain, and register in the forms hereinafter prescribed, the number of Native or Country boats from 50 maunds' burden and upwards, of Passenger boats such as Pinnaces and Budgerows, and of Steam-boats with their names, which may pass a given point on the bank of the river up or down, between daylight and dark; you will also be requested to register the number of timber or bamboo floats which may similarly pass down the river.

4th. A post should be put up on the river bank opposite your residence, you should fix a line from it to some object on the opposite bank; and you should make the proper entry in your register, as the boat or whatever it be, passes across this line up or down stream, you must be careful not to make the entry in anticipation of its crossing, but adhere closely to the rule of making that entry immediately after passing.

5th. You will be able by the eye, and with the aid of your telescope, to form a sufficiently correct estimate of the burden of boats passing, to enable you to class them as follows:—

Country boats,	A	from	50 to	200 maunds.
„	B	do.	200 to	500 do.
„	C	do.	500 to	1,000 do.
„	D	do.	1,000 and upwards.	

Passenger boats will include Budgerows, Bauleeahs and Pinnaces.

Steam-boats must be named as well as number registered.

Floats will include timber, bamboos and firewood drifts.

6th. You will be careful to observe that you are on no account yourself to visit, nor to allow any person connected with you to visit any boat, upon any pretence whatever.

7th. You will keep a daily register up and down, according to the form annexed. These registers should be on a table, and as each description of boat passes, you should insert a stroke in the proper column. At night you will close the account and put down in figures the totals of these entries. From these you will compile your weekly register.

8th. Your weekly register will be in the same form, and will be prepared and submitted at close of the following dates:—From 1st to 7th, 8th to 14th, from 15th to 21st, from 22nd to the end of the month.

9th. In the column of remarks you will note down the state of the weather, general direction of the wind, if rain has fallen, and so forth.

10th. Your weekly reports will be enclosed to this office on service packets, signed by the Magistrate, through whom you will receive any further orders, if necessary.

11th. The Magistrate will be requested to place two chupprassies to attend and assist you in keeping the look out, you will be careful to see that they do not offend against the prohibition of the 6th Rule.

12th. The Head Clerk of this office will supply you with the requisite stationery.

(Signed) E. A. READE,
Commissioner.

28*th June*, 1847.

Up Register.

Month.	Date.	Country Boats.				Total Maunds.	Passenger Boats.	Steamers.	Remarks.
		Class A. Average 125.	Class B. Average 350.	Class C. Average 750.	Class D. Average 1,500.				
July,...	1	111111111	1111111	1111111	1111		11111	Patna	W. Easterly Squalls and Rain.
		11111111	111111	111111	1111			MacLeod	
		1111		11		30,425			
		T 21 × 125 2,625 m.	T 13 × 350 4,550 m.	T 15 × 750 11,250 m.	T 8 × 1,500 12,000 m.		5	2	

Down Register.

The same with an additional column for Rafts or Floats.

Yearly Abstract of the Up Register of Boats from the 1st July 1847 to 30th June, 1848.

Description of Boats.	Number.	Tonnage.	Total Boats.	Total Tonnage.
Class A. Boats from 50 to 200 Maunds average 125 Maunds, ...	725	90,625		
B. do. do. 200 to 500 do. 350 do., ...	1,695	5,93,250		
C. do. do. 500 to 1,000 do. 750 do., ...	2,150	16,12,500		
D. do. do. 1,000 and upwards do. 1,500 do., ...	1,789	26,83,500	6,359	49,79,875

Passenger Boats—

Budgerows, 58

Pinnaces, 17

Bauleeahs, 11

STEAMERS.

The MacLeod, ...	7 Trips.	Thames, ...	3 Trips.
Berhampootur, ...	4 Do.	Megna, ...	4 Do.
Benares, ...	7 Do.	Sir F. Currie, ...	5 Do.
Damoodah, ...	3 Do.	Jumna, ...	5 Do.
Mahanuddee, ...	6 Do.	Horungotta, ...	5 Do.
Patna, ...	7 Do.	Indus, ...	1 Do.
Nurbudda, ...	3 Do.	Mirzapoor, ...	2 Do.
Assam, ...	4 Do.	Kasheejee, ...	1 Do.
Bentinck, ...	7 Do.	Total No. of Trips, ...	74

(Signed) E. A. READE,
Commissioner.

Yearly Abstract of the Down-Register of Boats, from 1st July, 1847 to 30th June, 1848.

Description of Boats.	Number.	Tonnage.	Total Boats.	Total Tonnage.
Class A. Boats from 50 to 200 Maunds average 125 Maunds, ...	885	1,10,625		
B. do. do. 200 to 500 do. do. 350 do., ...	1,863	6,52,050		
C. do. do. 500 to 1,000 do. do. 750 do., ...	2,255	16,91,250		
D. do. do. 1,000 and upwards do. 1,500 do., ...	2,019	30,28,500	7,022	54,82,425

Passenger Boats—

Budgerows, ... 49

Pinnaces, ... 9

Bauleeahs,... 4

STEAMERS.

The Thames, ...	4 Trips.	Nerbudda, ...	3 Trips.
Bentinck, ...	7 Do.	Megna, ...	4 Do.
MacLeod, ...	6 Do.	Sir F. Currie, ...	5 Do.
Benares, ...	7 Do.	Jumna, ...	5 Do.
Berhampootur, ...	4 Do.	Horungotta, ...	5 Do.
Damoodah, ...	3 Do.	Indus, ...	1 Do.
Patna, ...	7 Do.	Mirzapoor, ...	2 Do. Floats, 33.
Mahanuddee, ...	6 Do.	Total No. of Trips,...	73
Assam, ...	4 Do.		

(Signed) E. A. READE,

Commissioner.

Quarterly Abstract of the Up-Register of Boats for July, August and September, 1847.

Description of Boats.	Number.	Tonnage.	Total Boats.	Total Tonnage.
Class A. Boats from 50 to 200 Maunds average 125 Maunds, ...	187	23,375		
B. do. do. 200 to 500 do. do. 350 do., ...	405	1,41,750		
C. do. do. 500 to 1,000 do. do. 750 do., ...	589	4,41,750		
D. do. do. 1,000 and upwards do. 1,500 do., ...	325	4,87,500	1,506	10,94,375

Passenger Boats—

Budgerows, ... 10

Pinnaces, ... 4

Bauleeahs,... 3

STEAMERS.

The MacLeod,.....	2 Trips.	Nerbudda, ...	2 Trips.
Berhampootur, ...	3 Do.	Assam, ...	1 Do.
Benares, ...	3 Do.	Bentinck, ...	2 Do.
Damoodah, ...	2 Do.	Thames,.....	1 Do.
Mahanuddy, ...	2 Do.	Megna, ...	1 Do.
Patna, ...	2 Do.	Sir F. Currie, ...	1 Do.

(Signed) E. A. READE,

Commissioner.

Quarterly Abstract of the Up-Register of Boats, for October, November and December, 1847.

Description of Boats.	Number.	Tonnage.	Total Boats.	Total Tonnage.
Class A. Boats from 50 to 200 Maunds average 125 Maunds, ...	181	22,625		
B. Do. do. 200 to 500 do. do. 350 do., ...	362	1,26,700		
C. Do. do. 500 to 1,000 do. do. 750 do., ...	428	3,21,000		
D. Do. do. 1,000 and upwards do. 1,500 do., ...	375	5,62,500	1,346	10,32,825

Passenger Boats—

Budgerows, ... 13

Pinnaces, ... 2

Bauleeahs,... 7

STEAMERS.

The MacLeod,.....	2 Trips.	Assam, ...	1 Trip.
Berhampootur,.....	1 Do.	Bentinck, ...	2 Do.
Benares, ...	2 Do.	Thames,.....	1 Do.
Mahanuddee, ...	2 Do.	Sir F. Currie, ...	1 Do.
Patna, ...	2 Do.	Jumna, ...	2 Do.
Nerbudda, ...	1 Do.	Horungotta, ...	2 Do.

(Signed) E. A. READE,

Commissioner.

10 Sept 53.

Quarterly Abstract of the Up-Register of Boats, for January, February and March, 1848.

Description of Boats.	Number.	Tonnage.	Total Boats.	Total Tonnage.
Class A. Boats from 50 to 200 Maunds average 125 Maunds, ...	185	23,125		
B. Do. do. 200 to 500 do. do. 350 do., ...	398	1,39,300		
C. Do. do. 500 to 1,000 do. do. 750 do., ...	430	3,22,500		
D. Do. do. 1,000 and upwards do. 1,500 do., ...	388	5,82,000	1,401	10,66,925

Passenger Boats—

Budgerows, ... 21 *Pinnaces*,... 7

Bauleeah,... 1

STEAMERS.

The MacLeod,.....	1 Trip.	Megna, ...	1 Trip.
Benares, ...	1 Do.	Sir F. Currie, ...	2 Do.
Mahanuddee, ...	1 Do.	Jumna, ...	2 Do.
Patna, ...	2 Do.	Horungotta, ...	2 Do.
Assam, ...	1 Do.	Indus, ...	1 Do.
Bentinck, ...	2 Do.	Mirzapoor, ...	1 Do.
Thames,.....	1 Do.		

(Signed) E. A. READE,

Commissioner.

Quarterly Abstract of the Up-Register of Boats, for April, May and June, 1848.

Description of Boats.	Number.	Tonnage.	Total Boats.	Total Tonnage.
Class A. Boats from 50 to 200 Maunds average 125 Maunds, ...	172	21,500		
B. Do. do. 200 to 500 do. do. 350 do., ...	530	1,85,500		
C. Do. do. 500 to 1,000 do. do. 750 do., ...	703	5,27,250		
D. Do. do. 1,000 and upwards do. 1,500 do., ...	701	10,51,500	2,106	17,85,750

Passenger Boats— *Budgerows*,... 14

Pinnaces,... 4

STEAMERS.

The MacLeod,.....	2 Trips.	Mahanuddy, ...	1 Trip.
Damoodah, ...	1 Do.	Bentinck, ...	1 Do.
Megna, ...	2 Do.	Mirzapoor.....	1 Do.
Horungotta,.....	2 Do.	Kasheejee, ...	1 Do.
Sir F. Currie, ...	1 Do.	Jumna,.....	1 Do.
Patna, ...	1 Do.	Benares, ...	1 Do.
Assam, ...	1 Do.		

(Signed) E. A. READE,

Commissioner.

Quarterly Abstract of the Down-Register of Boats, for July, August and September, 1847.

Description of Boats.	Number.	Tonnage.	Total Boats.	Total Tonnage.
Class A. Boats from 50 to 200 Maunds average 125 Maunds, ...	367	45,875		
B. Do. do. 200 to 500 do. do. 350 do., ...	622	2,17,700		
C. Do. do. 500 to 1,000 do. do. 750 do., ...	599	4,49,250		
D. Do. do. 1,000 and upwards do. 1,500 do., ...	437	6,55,500	2,025	13,68,325

Passenger Boats—

Pinnaces, ... 2

Budgerows,... 14

Bauleeahs,... 2

STEAMERS.

The Thames, ...	2	Trips down.	Patna, ...	2	Trips down.
Bentinck, ...	3	Do.	Mahanuddy, ...	2	Do.
MacLeod, ...	2	Do.	Assam, ...	1	Do.
Benares, ...	2	Do.	Nerbudda, ...	2	Do.
Berhampootur, ...	2	Do.	Megna, ...	1	Do. Floats, 2.
Damoodah, ...	2	Do.			

(Signed) E. A. READE,

Commissioner.

Quarterly Abstract of the Down-Register of Boats, for October, November and December, 1847.

Description of Boats.	Number.	Tonnage.	Total Boats.	Total Tonnage.
Class A. Boats from 50 to 200 Maunds average 125 Maunds, ...	200	25,000		
B. Do. do. 200 to 500 do. do. 350 do., ...	452	1,58,200		
C. Do. do. 500 to 1,000 do. do. 750 do., ...	563	4,22,250		
D. Do. do. 1,000 and upwards do. 1,500 do., ...	398	5,97,000	1,613	12,02,450

Passenger Boats—

Pinnaces, ... 4

Budgerows,.. 13

STEAMERS.

The Thames, ...	1 Trip.	Assam, ...	1 Trip.
Bentinck, ...	1 Do.	Nerbudda, ...	1 Do.
MacLeod, ...	1 Do.	Megna, ...	1 Do.
Benares, ...	3 Do.	Sir F. Currie, ...	2 Do.
Berhampootur, ...	2 Do.	Jumna, ...	2 Do.
Patna, ...	2 Do.	Horungotta, ...	1 Do.
Mahanuddy, ...	1 Do.		

Floats, 8.

(Signed) E. A. READE,
Commissioner.

Quarterly Abstract of the Down-Register of Boats, for January, February and March, 1848.

Description of Boats.	Number.	Tonnage.	Total Boats.	Total Tonnage.
Class A. Boats from 50 to 200 Maunds average 125 Maunds, ...	134	16,750		
B. Do. do. 200 to 500 do. do. 350 do., ...	376	1,31,600		
C. Do. do. 500 to 1,000 do. do. 750 do., ...	572	4,29,000		
D. Do. do. 1,000 and upwards do. 1,500 do., ...	698	10,47,000	1,780	16,24,350

Passenger Boats —

Pinnaces,... 2

Budgerows,... 11

STEAMERS.

The Thames, ...	1 Trip.	Megna, ...	1 Trip.
Bentinck, ...	2 Do.	Sir F. Currie, ...	2 Do.
MacLeod, ...	2 Do.	Jumna, ...	2 Do.
Benares, ...	1 Do.	Horungotta, ...	2 Do.
Patna, ...	2 Do.	Indus, ...	1 Do.
Mahanuddy, ...	2 Do.	Mirzapoor, ...	1 Do. Floats, 9.
Assam, ...	1 Do.		

(Signed) E. A. READE,

Commissioner.

Quarterly Abstract of the Down Register of Boats for April, May, and June, 1848.

Description of Boats.	Number.	Tonnage.	Total Boats.	Total Tonnage.
Class A. Boats from 50 to 200 Maunds average 125 Maunds, ...	184	23,000		
B. Do. do. 200 to 500 do. do. 350 do., ...	413	1,44,550		
C. Do. do. 500 to 1,000 do. do. 750 do., ...	521	3,90,750		
D. Do. do. 1,000 and upwards do. 1,500 do., ...	486	7,29,000	1,604	12,87,300

Passenger Boats—

Budgerows, 11

Pinnace, 1

Bauleeahs, 2

STEAMERS.

The MacLeod, ...	1 Trip.	Bentinck,.....	1 Trip.
Damoodah, ...	1 Do.	Assam, ...	1 Do.
Megna, ...	1 Do.	Mirzapoor, ...	1 Do.
Horungotta, ...	2 Do.	Mahanuddee, ...	1 Do.
Sir F. Currie, ...	1 Do.	Jumna, ...	1 Do.
Patna, ...	1 Do.	Benares, ...	1 Do.

Flats, 14.

(Signed) E. A. READE,
Commissioner.

MEMO. of Expenses incurred in ascertaining the traffic and removing the obstructions of the River Ganges in 1847-48, *taken from the Treasury Account entries of the Benares Collectorship.*

N. B. Credit given by transfers to Collectors of Mirzapore and Ghazeepore.

Salary of Mr. H. Alone, River Inspector, from July 1847 to June 1848, at 50 Rs. per month,	.....		600 0 0
Salary of Mr. W. Lloyd, Superintendent of the Operations, from December 1847 to May 1848, at 400 Rs. per month, ... 2,400 0 0			
Advance as per his receipt, dated 5th September 1848,..... 300 0 0			
	2,700 0 0		
His establishment from December 1847 to April 1848,.....	1,097 1 0		
Contingent charges from ditto to ditto, ...	391 12 1		
		4,188 13 1	
Salary of Mr. J. Bromley, Overseer, from 23rd to 30th December 1847, at 50 Rs. per month, ...	15 0 0		
His establishment, ...	9 14 3		
		24 14 3	
Salary of Sergeant Jackson, River Overseer, from 15th November 1847 to March 1848, at 50 Rs. per month, ...	225 0 0		
His establishment,.....	148 8 0		
Contingent charges, ...	25 0 0		
		398 8 0	
Salary of Sergeant Bigwood, River Overseer, from December 1847 to 22nd May 1848, at 50 Rs. per month, ...	280 14 0		
His establishment, from ditto to April 1848, ...	165 0 0		
Contingent charges, ...	215 6 3		
		661 4 3	
Salary of Mr. Barry, Inspector of Obstructions in the Ganges, from 19th to 30th November 1847, at 100 Rs. per month,..... 40 0 0			
Ditto from January to April 1848, ... 400 0 0			
	440 0 0		
His establishment, from 19th to 30th November 1847,..... 75 13 9			
Ditto from January to April 1848, ... 124 0 0			
	199 13 9		
Contingent charges, ...	143 2 0		
		782 15 9	
Salary of Sergeant Halt, River Overseer, from 1st April to 15th May 1848, at 50 Rs. per month, ...	75 0 0		
His establishment,.....	49 8 0		
	124 8 0		
Deduct,.....	8 14 0		
		115 10 0	
1 Contingent Bill of River Cleaning Department, passed by the Commissioner, on the 19th December 1847, ...	.....	20 0 0	
Paid to the Commissioner on account of Mr. Barry, Supervisor, for 15 days in May 1848, *vide* Commissioner's order, dated 29th May 1848, No. 22,.....	66 8 0		
Contingent charges, ...	2 0 0		
		68 8 0	
Overseer Bromley, and establishment for April,.....	83 0 0		
Ditto Clayton, for ditto,.....	83 0 0		
Mr. Drane, Clerk and Tindal, for ditto,.....	34 0 0		
		200 0 0	
Making a Shed for the protection of Stores, ...	.....	15 4 0	
Total,.....	.....	7,075 13 4	
Due to Mr. Lloyd for June,.....	.....	100 0 0	
		7,175 13 4	

E. E.

(Signed) E. A. READE,
Commissioner, 5th Division.

Extract from a letter from Captain A. H. E. BOILEAU, *to the Hon'ble the Lieutenant Governor, N. W. P., dated the 16th September,* 1848.

Remarks on the operations for improving the Navigation of the Ganges River.

Under my present want of enlightment as to what has been done during the current year by Mr. Lloyd or any body else employed under Mr. Reade, I can only answer your questions in rather an indefinite way; but I may state—

1st. That I anticipate benefit from further operations, and to recommend their continuance.

2nd. The nature of the operations which I recommend is to watch the various channels left on the subsidence of the main stream at the cessation of the Rainy Season, and by means of Bandahls, or in any similar manner to lead the whole of the water into the two most likely looking channels, one for upward bound and the other for downward bound boats; shutting up all other channels with stakes and mats, clay dams, or in any other manner, where the obstructions are only banks of sand or other such soft substance. Where there is a reef or bar either of stiff clay, kunkur or rock, I would only excavate two reasonable broad channels defining them well with posts or buoys, and I would not expend labor and money uselessly and perhaps mischievously in removing the whole bar which might perhaps be of great service as a dam or wier in holding up the water to a navigable depth in the upper reaches of the river.

3rd. Neither I nor the Executive Engineer at Allahabad have leisure to superintend any part of such operations, so long as we are encumbered with our present unmanageble quantum of work of other kinds.

4th. As regards establishment and money, I think that an Assistant Executive Officer at 200, with four Assistant Overseers at 70 rupees each, one English Writer at 30, four Native Lallas at 10, two Wrecking Boats of 1,200 at 1,500 maunds with a proportionate crew, four Tindals, twenty Lascars, and eight Dingees with three boatmen to each, say 200 × 280 × 30 × 40 × 210 × 28 × 100 × 96 × 16 for stationery; total 1,000 rupees monthly for permanent establishment, with perhaps 500 rupees more for working parties, and materials would suffice for the half of the line, (say from Allahabad to Sultanpore, Benares;) and a similar expenditure of 1,500 rupees monthly for the other half of the line from Sultanpore, Benares, to Bulleeah, the total contemplated outlay being 3,000 rupees per mensem.

The above establishment I consider as a maximum, and probably sufficient to perform, in a single season, nearly all that is required for opening a double line of navigable channels, which should not any where have less than 5 or 6 feet of water in them at the very lowest fall of the river. When once a pair of channels of this kind has been established, perhaps a third part of the above outlay would be sufficient to keep open the navigation during future seasons.

The Assistant Executive Officers might be either under the immediate order of the Commissioner of Benares or of the Superintending Engineer, or of any person appointed by Government to device and to regulate the operations as far as could be done upon paper; or one of them might be attached to the Benares, and the other one to the Allahabad Division, so that this work would be wholly in the hands of professional persons, and the Assistants might make themselves useful to their superior Executive Officers in the Department of Public Works, while the river operations happen to be at a stand still.

I have not retained any copy of this hasty memorandum, but hope that it may answer the purpose for which it was intended.

(True Copy,)

(Signed) C. ALLEN.
Officiating Secretary.

J. C. SHERRIFF, BENGAL MILITARY ORPHAN PRESS.

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